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IRVING L. OWEN, B.S., *Co. Supt. of Farm Demonstration for Middlesex Co.*
GEORGE T. REID, *Co. Supt. of Farm Demonstration for Burlington Co.*
WARREN W. OLEY, B.S., *Co. Supt. of Farm Demonstration for Cumberland Co.*
A. M. GOODMAN, B.S., *Co. Supt. of Farm Demonstration for Morris Co.*
ELWOOD L. CHASE, B.S., *Co. Supt. of Farm Demonstration for Passaic Co.*

Letter of Transmittal

To His Excellency, James F. Fielder, Governor of the State of New Jersey:

SIR—I have the honor to submit herewith the Thirty-seventh Annual Report of the New Jersey State Agricultural Experiment Station, as required by the law establishing the Station, which was approved March 10, 1880, and which is chapter 106 of the laws of that year.

JAMES S. NEILSON,
President.

NEW BRUNSWICK, N. J., November 30, 1916.

To His Excellency, James F. Fielder, Governor of the State of New Jersey:

SIR—In compliance with an act of Congress, approved March 2, 1887, and with an act of the Legislature of this State, approved March 5, 1888, I beg leave to submit, on behalf of the Trustees of Rutgers College in New Jersey, maintaining Rutgers Scientific School, the New Jersey State College for the benefit of Agriculture and Mechanic Arts, the Twenty-ninth Annual Report of the operations of that department of the College which has been organized in accordance with said act of Congress, and is known as "The State Agricultural College Experiment Station."

W. H. S. DEMAREST,
President.

NEW BRUNSWICK, N. J., November 30, 1916.

Treasurer's Report

Irving E. Quackenboss, in account with the New Jersey State Agricultural Experiment Station, November 1st, 1915, to October 31st, 1916.

APROPRIATION FOR SALARIES AND EXPENSES

Appropriation	$25,000.00
Collections for Sales of Milk, Cream, and Dairy Stock, Glassware Tested, and Milk Testers' Licenses Issued	8,616.22
Collections for Sales of Swine	1,916.73
Collections for Sales of Peaches	1,059.68
Refund for subscription to the Journal of the Association of Official Agricultural Chemists	1.00
Total	$36,593.63

Payments

By Treasurer of the Experiment Station—	
Salaries and Wages	$16,956.89
Bills submitted to State Comptroller for direct payment—	
Books and Magazines	328.51
Chemical Supplies	339.95
Coal	869.16
Electric Current	853.35
Express, Freight, and Cartage	800.59
Farm Machinery and Tools	476.70
Feed and Shavings	4,271.78
Fertilizers	1,051.34
Gas	248.06
Insurance	762.63
Labor	1,689.53
Live Stock	965.00
Office Furniture	54.00
Office Supplies	230.88
Photographic Supplies and Blue Prints	100.00
Postage	947.10
Printing and Stationery	1,174.27
Registration of Animals	45.50
Repairs	446.05
Scientific Apparatus	211.17
Team Hire	222.00
Telephone	928.11
Telegraph	173.71
Traveling Expenses—Managers	313.54
Traveling Expenses—Officers	570.34
Traveling Expenses—Sampling Feeds	322.90
Trees, Seeds, and Vines	333.15
Veterinary Services	295.40
Water and Ice	180.60
Sundries	209.20
Amount reserved by requisition until next fiscal year	133.38
Total	$36,504.75

APPROPRIATION FOR PRINTING BULLETINS

Appropriation	$6,700.00

Payments

Bills submitted to State Comptroller for direct payment—	
For Printing Bulletins	$6,698.01

Appropriation for the Purpose of Carrying into Effect "An Act to Provide for Locating and Abolishing Mosquito-Breeding Salt Marsh Areas within the State, for Assistance in Dealing with Certain Inland Breeding Places, and Appropriating Money to Carry its Provisions into Effect."

Appropriation	$4,800.00

Payments

By Treasurer of the Experiment Station—	
Salaries and Wages	$3,009.68
Bills submitted to State Comptroller for direct payment—	
Labor	151.91
Office Supplies	25.50
Photographic Supplies and Blue Prints	14.00
Postage	50.50
Printing and Stationery	43.35
Scientific Apparatus	10.00
Telephone	20.93
Telegraph	1.59
Traveling Expenses—Officers	1,342.35
Sundries	49.05
Total	$4,718.86

APPROPRIATION FOR CARRYING OUT THE PROVISIONS OF "AN ACT TO REGULATE THE SALE OF INSECTICIDES"

Appropriation	$1,000.00

Payments

By Treasurer of the Experiment Station—	
Salaries and Wages	$675.00
Bills submitted to State Comptroller for direct payment—	
Chemical Supplies	200.33
Scientific Apparatus	123.32
Total	$998.65

APPROPRIATION FOR THE SCIENTIFIC INVESTIGATION OF OYSTER PROPAGATION

Appropriation	$900.00

Payments

By Treasurer of the Experiment Station—	
Salaries and Wages	$630.00
Bills submitted to State Comptroller for direct payment—	
Hardware	87.46
Insurance	25.50
Office Supplies	.15
Overhauling and Storage of Boats	55.06
Postage	1.18
Rent of Land	15.00
Scientific Apparatus	44.90
Traveling Expenses—Officers	30.87
Total	$890.12

APPROPRIATION FOR THE MAINTENANCE AND OPERATION OF THE DEPARTMENT OF POULTRY HUSBANDRY

Appropriation	$6,500.00
Collections for Sales of Poultry and Eggs	4,717.20
Total	$11,217.20

Payments

By Treasurer of the Experiment Station—	
Salaries and Wages	$7,195.00
Bills submitted to State Comptroller for direct payment—	
Books and Magazines	9.00
Chemical Supplies	45.50
Coal	260.54
Fertilizers	10.00
Hatching Eggs	26.25
Labor	11.50
Office Furniture	263.94
Office Supplies	11.26
Photographic Supplies and Blue Prints	144.80
Postage	29.78
Poultry Feed and Litter	1,448.51
Poultry Stock	113.56
Poultry Supplies and Tools	554.32
Printing and Stationery	176.59
Repairs	146.95
Team Hire	29.40
Telephone	.36
Traveling Expenses—Officers	368.44
Trees, Seeds and Vines	24.22
Sundries	106.35
Amount reserved by requisition until next fiscal year	106.00
Total	$11,082.27

APPROPRIATION FOR CARRYING OUT THE PROVISIONS OF "AN ACT CONCERNING SEEDS"

Appropriation	$2,500.00

Payments

By Treasurer of the Experiment Station—	
Salaries and Wages	$2,076.66
Bills submitted to State Comptroller for direct payment—	
Office Supplies	40.65
Photographic Supplies and Blue Prints	3.45
Postage	.20
Printing and Stationery	35.85
Repairs	3.43
Scientific Apparatus	84.34
Telephone	.45
Traveling Expenses—Officers	229.79
Seeds	11.62
Sundries	7.82
Total	$2,494.26

APPROPRIATION FOR BUILDINGS, FENCES AND EQUIPMENT IN THE DEPARTMENT OF POULTRY HUSBANDRY

Appropriation	$5,000.00

Payments

By Treasurer of the Experiment Station—	
Salaries and Wages	$1,293.00
Bills submitted to State Comptroller for direct payment—	
Buildings, Fences, and Equipment	3,538.00
Labor	143.60
Amount reserved by requisition until next fiscal year	24.67
Total	$4,999.27

APPROPRIATION FOR CRANBERRY INVESTIGATION

Appropriation	$1,500.00

Payments

By Treasurer of the Experiment Station—	
Salaries and Wages	$1,150.00
Bills submitted to State Comptroller for direct payment—	
Express, Freight and Cartage	.85
Field Supplies	20.57
Office Supplies	.70
Printing and Stationery	7.00
Telephone	3.41
Telegraph	.76
Traveling Expenses—Officers	299.25
Total	$1,482.54

APPROPRIATION FOR THE PURPOSE OF MAINTAINING AND CARRYING ON EXPERIMENTAL WORK IN FLORICULTURE.

Appropriation	$3,000.00
Collections for Sales of Flowers	1,719.97
Total	$4,719.97

Payments

By Treasurer of the Experiment Station—	
Salaries and Wages	$2,805.00
Bills submitted to State Comptroller for direct payment—	
Chemical Supplies	16.69
Coal	968.64
Fertilizers	20.25
Floriculture Supplies and Tools	241.19
Labor	112.88
Photographic Supplies and Blue Prints	127.71
Printing and Stationery	55.15
Repairs	147.61
Scientific Apparatus	12.35
Trees, Seeds and Vines	139.50
Total	$4,646.97

APPROPRIATION FOR FARM DEMONSTRATION IN AGRICULTURE

Appropriation	$15,000.00

Payments

By Treasurer of the Experiment Station—	
Salaries and Wages	$12,130.84
Bills submitted to State Comptroller for direct payment—	
Chemical Supplies	92.39
Express, Freight and Cartage	78.49
Farm Machinery and Tools	22.84
Fertilizers	20.39
Labor	37.95
Office Furniture	139.00
Office Supplies	125.28
Photographic Supplies and Blue Prints	22.80
Postage	90.70
Printing and Stationery	502.90
Scientific Apparatus	14.00
Telephone	6.66
Telegraph	.93
Toward Maintenance of Mercer County Farm Bureau	400.00
Traveling Expenses—Officers	1,111.42
Trees, Seeds and Vines	121.26
Sundries	33.00
Total	$14,950.85

APPROPRIATION FOR LAND, BUILDINGS AND EQUIPMENT FOR THE ESTABLISHMENT OF A BRANCH EXPERIMENT STATION IN SOUTH JERSEY

Appropriation	$25,000.00

Payments

Bills submitted to State Comptroller for direct payment—	
Traveling Expenses—Managers	$235.95
Search and Recording Deed	261.75
Surveying	179.41
Total	$677.11

Note—The land was not purchased, so the balance of this appropriation reverted to the State Treasury.

APPROPRIATION FOR THE MAINTENANCE OF A BRANCH EXPERIMENT STATION IN SOUTH JERSEY

Appropriation	$3,000.00

Note—As the land for the Branch Experiment Station was not purchased, there were no charges against this account, the entire appropriation reverting to the State Treasury.

FEED INSPECTION FEES ACCOUNT

Appropriation—Collection of Feed Inspection Fees	$18,924.09

Payments

By Treasurer of the Experiment Station—	
Salaries and Wages	$6,955.62
Bills submitted to State Comptroller for direct payment—	
Chemical Supplies	6.10
Electric Current	199.31

Express, Freight and Cartage	160.95
Farm Machinery and Tools	24.86
Feed and Shavings	9,444.94
Gas	110.55
Labor	228.00
Office Supplies	95.08
Photographic Supplies and Blue Prints	12.47
Postage	406.93
Printing and Stationery	164.35
Repairs	24.82
Telephone	4.05
Telegraph	3.16
Traveling Expenses—Officers	403.26
Traveling Expenses—Sampling Feeds	135.30
Veterinary Services	28.75
Water and Ice	17.80
Sundries	47.12
Amount reserved by requisition until next fiscal year	19.05
Total	$18,492.47

FERTILIZER INSPECTION FEES ACCOUNT

Appropriation—Collection of Fertilizer Inspection Fees	$19,371.78

Payments

By Treasurer of the Experiment Station—	
Salaries and Wages	$15,830.53
Bills submitted to State Comptroller for direct payment—	
Chemical Supplies	21.43
Coal	9.88
Express, Freight and Cartage	35.02
Farm Machinery and Tools	54.51
Fertilizers	13.50
Labor	218.38
Office Supplies	187.86
Peach Crates	46.50
Photographic Supplies and Blue Prints	63.85
Postage	234.95
Printing and Stationery	815.75
Repairs	21.90
Scientific Apparatus	153.72
Straw	15.32
Telephone	3.05
Telegraph	.62
Traveling Expenses—Officers	603.72
Traveling Expenses—Sampling Fertilizers	776.82
Trees, Seeds and Vines	203.92
Water and Ice	12.00
Sundries	42.41
Total	$19,365.64

COLLECTION ACCOUNT

Receipts

From Poultry Department—	
Collection for Sales of Poultry and Eggs	$4,717.20
From Floriculture Department—	
Collections for Sales of Flowers	1,719.97

From Horticulture Department—	
Collections for Sales of Peaches	1,059.68
From Dairy Department—	
Collections for Sales of Milk, Cream, and Dairy Stock, Glass-ware Tested, and Milk Testers' Licenses Issued	8,616 22
From Swine Department—	
Collection for Sales of Swine	1,916.73
From Chemical Department—	
Collection of Fertilizer Inspection Fees	19,371.78
From Chemical Department—	
Collection of Feed Inspection Fees	18,924.09
From Association of Official Agricultural Chemists—	
Refund for Subscription to Journal	1.00
Total	$56,326 67

Payments

To State Treasurer—	
Collections for Sales of Poultry and Eggs	$4,717.20
To State Treasurer—	
Collections for Sales of Flowers	1,719.97
To State Treasurer—	
Collections for Sales of Peaches	1,059.68
To State Treasurer—	
Collections for Sales of Milk, Cream, and Dairy Stock, Glass-ware Tested, and Milk Testers' Licenses Issued	8,616.22
To State Treasurer—	
Collections for Sales of Swine	1,916.73
To State Treasurer—	
Collection of Fertilizer Inspection Fees	19,371.78
To State Treasurer—	
Collection of Feed Inspection Fees	18,924.09
To State Treasurer—	
Refund for Subscription to Journal	1.00
Total	$56,326 67

The Auditing Committee of the Experiment Station has examined the accounts of the Treasurer of said station, and has found them correct.

(Signed) GEORGE E. DECAMP,
GEORGE SMITH,
Auditing Committee.

Financial Statement

NEW JERSEY STATE AGRICULTURAL COLLEGE EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES APPROPRIATION, 1915–1916

Dr.		*Hatch Fund*	*Adams Fund*
To Receipts from the Treasurer of the United States as per Appropriations for Fiscal Year Ended June 30th, 1916, Under Acts of Congress Approved March 2d, 1887 (Hatch Fund), and March 16th, 1906 (Adams Fund), ...		$15,000.00	$15,000.00
Cr.	*Abstracts*		
By Salaries	1	$10,240.02	$11,343.32
Labor	2	955.29	1,513.90
Publications	3	116.38	....
Postage and Stationery	4	369.73	8.18
Freight and Express	5	107.12	23.31
Heat, Light, Water, and Power	6	336.02	339.60
Chemicals and Laboratory Supplies	7	456.35	871.17
Seeds, Plants, and Sundry Supplies.	8	290.49	138.19
Fertilizers	9	74.17	12.82
Feeding Stuffs	10	....	360.00
Library	11	101.09	58.55
Tools, Machinery, and Appliances ..	12	146.21	158.28
Furniture and Fixtures	13	322.23	12.10
Scientific Apparatus and Specimens.	14	239.10	35.45
Live Stock	15	....	....
Traveling Expenses	16	870.01	41.59
Contingent Expenses	17	2.00	....
Buildings and Land	18	373.79	83.54
		$15,000.00	$15,000.00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the New Jersey State Agricultural College Experiment Station for the fiscal year ended June 30th, 1916; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was $........ on the Hatch Fund and $........ on the Adams Fund; that the receipts for the year from the Treasurer of the United States were $15,000.00 under the act of Congress of March 2d, 1887, and $15,000.00 under the act of Congress of March 16th, 1906, and the corresponding disbursements of $15,000.00 and $15,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving balances of $........ and $........

And we further certify that the expenditures have been solely for the purpose set forth in the acts of Congress approved March 2d, 1887, and March 16th, 1906, and in accordance with the terms of said acts, respectively.

(Signed) W. H. S. DEMAREST,
J. G. LIPMAN,
Auditors.

REPORT OF THE DIRECTOR

Report of the Director

JACOB G. LIPMAN, PH.D., *Director*

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Report of the Director

JACOB G. LIPMAN

I

INTRODUCTION

As one of the factors in rural progress, agricultural education is assuming a more commanding position from year to year. The State Agricultural College is now finding a wider scope for service through the authority vested in it by the Federal Smith-Lever Act. Thus it is able to impart instruction not alone in organized classes in the long and short courses in agriculture, but to the much larger constituency in the several counties of the State. In coöperation with the Experiment Station, it has organized farm bureaus in 11 counties. It is employing a staff of extension specialists who act in an advisory capacity to landowners in New Jersey, and are, in fact, traveling instructors in agriculture. It publishes printed matter on topics of interest to farmers, and it makes members of its teaching staff available for lecturing to audiences in the State.

The State Department of Education is making its organization more effective in the rural districts, as well as in the urban centers. To the general education which it is offering alike to pupils in the city and country, it is adding courses in vocational training best calculated to bring young people into harmony with their particular environment. The sons and daughters of farmers are given an opportunity, in this manner, to gain a new interest in and a clearer understanding of the daily tasks on the farm and of their place in agricultural production. Aside from the project work in agriculture now conducted under its supervision, the State Department of Education is helping to organize agricultural courses in the rural high schools, and in due time will no doubt advocate the establishment of secondary schools where applied agriculture may be taught most effectively. It is also probable that the normal schools of the State will make more specific provision for adequately training the teachers of our rural schools.

Contributions to agricultural education are being made also by the New Jersey State Board of Agriculture. Its efforts are being directed toward awakening among the mass of producers the consciousness of common needs and of common responsibilities to a great industry. Its farmers' institutes, county board meetings and annual conventions are events distinctly educational in character. But even the police and statistical work of the State Board are not without some educational value. Nursery inspection, the control of tuberculosis among dairy cattle, the distribution of hog cholera serum, the study of foul brood of bees, and the gathering of information on markets and marketing all help in a more or less direct way to crystallize our knowledge of important agricultural problems.

In so far as they serve to enlighten the public on matters of agricultural production, the Department of Conservation and Development and the State Chamber of Commerce may be regarded with propriety as educational forces in agriculture. The first of these organizations is a consistent advocate of the rational development of the natural resources of the State. It recognizes the vast possibilities that lie in the soils and forests of New Jersey and is ever ready to give its enthusiastic support to such broad measures of public policy as would encourage the profitable use of the soils and forests. The State Chamber of Commerce, on its part, knows of the community of interest which must exist between the population of the city and country. It appreciates the interdependence of the producers and consumers of food. It appreciates the possibilities of wholesome legislation in behalf of the rural communities. With much discretion and intelligence, it is striving to mould public opinion in the interest of good roads, sanitation, education and community organization.

Not least among the forces that help to bring enlightenment and progress to rural New Jersey are the various agricultural societies and organizations. The State Horticultural Society, the State Poultry Association, the American Cranberry Growers' Association, the Breeders of Guernsey, Jersey and Holstein cattle, the North Jersey Agricultural Society, the farmers' exchanges and many other organizations all help to give the farmers helpful information and a broader outlook. Especial mention should be made, however, of the New Jersey State Grange and its pomona and subordinate granges. These are indeed educational institutions, for they lay much stress on their educational program. They do much for their members by bringing to them a better understanding of the social and economic problems that enter into the life of the farmer.

II

THE CALL FOR SERVICE

The Larger Service

There is need for all of the educational forces and agencies in the advance which is expected from the producers of agricultural commodities. The possibilities for agricultural expansion in New Jersey are still almost unlimited. Out of a total of 4,808,960 acres of land surface, there were improved in 1910 only 1,803,336 acres. There were, then, in 1910 more than 3,000,000 acres of unimproved land area in New Jersey. Since that time there have been increases in the acreage of the improved area in some localities and decreases in others. Altogether, there are now nearly one and three-quarter million acres of unimproved land in the southern counties of the State and approximately one and one-quarter million acres of unimproved land in the northern counties of the State. In South Jersey, three of the counties, viz.: Atlantic, Burlington and Ocean, possess considerably more than one million acres of land which is still to be made arable. Evidently, then, there is much elbow room in New Jersey and much constructive work which may be done when the time comes for placing a larger supply of food at the disposal of the rapidly growing urban population of the Atlantic Seaboard.

In considering broad constructive measures for the agricultural development of the State, one must reckon with a very considerable number of leading factors. In northern, as well as southern New Jersey, much of the land is still far from being accessible. There is need for the building of new roads and the improvement of roads already existing as one of the steps in the better utilization of our farm lands. Any plan for the rational development of a road system in New Jersey should include such tunnels under the Hudson and Delaware Rivers as would allow of the unhindered movement of motor-drawn and horse-drawn vehicles from New Jersey into New York and Pennsylvania. Such tunnels would at once attract large numbers of new settlers into the rural districts of the State, would enhance production and also lead to a substantial increase in taxable values. When considered from the standpoint of agricultural development, tunnels under the Hudson and Delaware Rivers should be regarded as very attractive investments, since the benefits to be derived would go to the consumers as well as to the producers of foods.

For a number of years the Station, and, later, the mosquito extermination commissions in a number of our counties, have striven to awaken the recognition among the people of the State that the mosquito pest is a problem of great economic magnitude. Notwithstanding the opposition from many directions, the leaders in mosquito extermination work in New Jersey have been able to convince a large portion of the intelligent public that mosquitoes can be reduced to such small numbers, if not entirely exterminated, as to prevent them from being a source of serious discomfort and a check on the development of much of the territory of the State. It is gratifying to note that in North Jersey, at least, the mosquito extermination activities of the county commissions and of the Station have been quite effective. In the counties of Essex, Hudson, Union and Bergen, the mosquito pest has been reduced to such an extent as to call forth enthusiastic comments in the daily press and among the residents of that territory. Because of the practical elimination of the serious annoyance from mosquitoes much of the suburban territory in these and adjoining counties has attracted new residents. An increasing number of suburban homes is being built in this territory and taxable values have been increased greatly. But, gratifying as has been the progress in mosquito extermination in northern New Jersey, there is still much to be done in South Jersey. If the same degree of success could be attained in that portion of the State in the elimination of mosquito-breeding areas, many thousands of acres of land in the counties of Cumberland, Cape May, Atlantic, Burlington and Ocean would be taken up and developed for agricultural purposes. The methods now employed in mosquito extermination have been sufficiently tested to make it certain that they would be quite adequate in accomplishing their purpose. It remains for the State and the counties concerned to provide the funds that would allow the completion of the work within the period of a few years. With the reduction of mosquitoes to insignificant numbers, one of the most serious checks on the agricultural development of a large portion of southern New Jersey will have been removed.

In considering agricultural development in New Jersey mention should be made of the large extent of meadow and swamp land which could be made more productive by means of suitable systems of drainage. These undrained lands are usually rich in plant-food and, thanks to their peculiar relation to the water supply, could be made to yield large harvests. They are suitable for the growing of forage crops for cattle as well as of vegetables of good quality. Mention may be made, also, in this con-

nection of the possibilities of overhead irrigation in making arable thousands of acres of the open sandy soils in the southern counties of the State.

As one thinks of the physical limitations in agricultural progress he is made to realize that the improvement of roads and other means of transportation, systems of drainage and irrigation, and the extermination of mosquitoes, are but single factors in the scheme of development. The welfare of the entire agricultural industry must, in the last analysis, depend on the effectiveness of the individual farmer as a food producer. His effectiveness will be determined by his industry, by his training and education and by the working capital which he may have at his disposal. But even with these he often feels helpless in a social and economic organization which is becoming more complex from year to year. He finds that the raw materials which he must have on the farm are controlled by large organizations of capital. He finds that he must meet a keener competition from the city industries in the labor market. He feels that much of the recent advance in industrial production has been made possible by the organization of large units. His is then a small enterprise, less economically managed, because it is smaller than a large industrial enterprise. The increasing cost of labor and raw materials are almost a menace to the present organization of agricultural production. It is becoming apparent that agriculture as an industry will have to find greater efficiency in production either by the organization of larger farm units or by coöperation among the smaller farm units. Students of agriculture realize that the organization under single management of very large farms containing many thousands of acres might be desirable from the standpoint of efficiency in production. They would be entirely undesirable in that they would destroy the existing social fabric of our rural communities, would seriously undermine the independence and initiative of the individual farmer, and would threaten the very existence of the farm home. Instead of a number of independent farmers, we should have then a few well-paid managers and a large number of hired men who would feel no direct responsibility in safeguarding the interests of the social and religious life of our rural districts. It is safe to predict, therefore, that the coming decades will see much change in methods of agricultural production and distribution. Farmers will learn to conserve labor by coöperative effort, particularly by the use of the more costly labor-saving machinery. Farmers will also learn to standardize their produce and to reach the consumer as directly as conditions may

permit. As a prerequisite of effective coöperation, the individual farmer will find himself in need of a better general education and of greater skill in the handling of his raw materials and of the implements of production.

The Special Service

The farmers of the State are insistently calling for certain service. Potato growers, both of central and southern New Jersey, feel that the potato crop is of sufficient importance to warrant the employment of a potato specialist at the Agricultural Experiment Station. The potato specialist should be available for a study of questions that, in the interest of the potato crop, call for an early answer. It is felt by the potato growers that means should be found for controlling potato diseases that are more or less troublesome. A study should be made of home-grown seed and the feasibility of depending on home-grown seed. A study should be made of fertilizer and other soil fertility problems peculiar to the growing of large crops of potatoes. A study should also be made of systems of cropping and of farm management that would bring the potato crop into more profitable relation to the other crops that may be grown in potato sections.

Strawberries, raspberries, blackberries, gooseberries and currants are important crops in sections of southern New Jersey and elsewhere. These crops have their insect enemies and fungous diseases which at times seriously interfere with profitable production. The entomologist of the Experiment Station has been fortunate in finding a satisfactory remedy against the destructive attacks of the strawberry weevil. Other work could be done profitably both in the control of insects and plant diseases and in improving by selection and breeding that would render berry production in New Jersey more certain and more profitable. The same may be said, also, of ornamental plants and of cut flowers. The value of these is becoming greater from year to year. There are insects and plant diseases peculiar to ornamental plants, and men should be available for the study of these problems, so that they may be disposed of to the satisfaction of the growers.

There is a strong demand for help in the dairy industry of the State. The cow-testing associations in North and South Jersey have already done much toward the elimination of unprofitable cows and in the introduction of better methods of feeding. Unfortunately, however, the cost of concentrated feeding stuffs has recently increased to such an extent as to make

milk production, notwithstanding the somewhat better prices of market milk, far from profitable. Much has been said in the agricultural press and in the daily papers concerning the apparently excessive cost of delivering milk to the consumer. It is not at all unlikely that better organization among the dairymen and coöperation in the buying of feeding stuffs, the further elimination of less profitable cows and the introduction of better forage crops and better methods of growing the more common forage crops, would result in such economies as to benefit both the producer and consumer of dairy products. The Experiment Station is expected to serve more largely than it is now serving in supplying advice as to feeding, breeding, the handling of milk and the construction of dairy buildings.

There is a growing conviction among the people in the State that there should be produced in New Jersey, if not all of the meat consumed by its residents, at least a much larger amount than is now being produced. It is true, no doubt, that the production of pork, mutton and beef may be encouraged and made profitable if such production is adjusted to the types of farming which prevail in the State. All will agree that much forage is now being wasted in New Jersey on the salt marsh, on fresh-water meadows and generally on our farms and in our forests. A system of meat production best suited to eastern conditions should be devised. Coöperation should play an important role in solving this particular problem.

The poultry industry of New Jersey has experienced within the past few years a truly remarkable growth. Poultry-keeping appeals to persons of limited capital. Such people can make a modest living out of the keeping of poultry. This is well proved by the establishment of many small plants in northern, middle and southern New Jersey, and the increasing production of eggs and meat for consumption in the nearby towns and cities. The entire industry will be benefited by more thorough organization among the producers, by coöperative buying and coöperative marketing, as well as the more intelligent dealing with poultry diseases that are often so costly and inimical to profitable poultry husbandry. The Poultry Department of the Station has rendered yeoman service to the industry in stimulating the organization of local poultry associations, in encouraging the introduction of modern methods of poultry-house construction and of feeding and breeding. The research work of the Poultry Department is bringing to light facts which should later prove of great value to the industry.

Vegetable growing is one of the specialized types of farming

year. Successful vegetable growing calls for high intelligence and skill and involves a knowledge of soil fertility, entomology, plant pathology and botany. Intensive methods are being practiced to an increasing extent. But, as the practice in vegetable growing becomes more intensive, the fertilizer, insect and plant disease problems also become more troublesome, hence a demand on the part of vegetable growers for special service in these directions. The staff of the Experiment Station is rendering such service as the present facilities will permit. It is hoped, however, that these facilities may be made more adequate through larger appropriations to the Station. Aside from production, the growers of vegetables recognize the needs for coöperative marketing and standardization of products. There is every indication that much progress is to be made in the near future in the organization of coöperative marketing among the growers of vegetables.

Fruit growing in New Jersey is one of the most progressive of its agricultural industries. Thanks to the energy and intelligence of the members of the New Jersey State Horticultural Society, the fruit growers of the State have learned to appreciate keenly the value of quality in fruit. The fruit exhibits at local fairs and at meetings of the county and State organizations are direct evidence that there has been ample progress made in fruit production. There has come to the fruit growers in the State much knowledge concerning fruit varieties, methods of planting, methods of fertilization, methods of spraying and methods of packing. Persons interested in New Jersey agriculture always experience a feeling of gratification and pride in inspecting the fruit exhibits of New Jersey fruit growers.

Another of the industries which occupies high rank in the State is that of cranberry production. The cranberry industry is a highly specialized one, and calls not alone for a large outlay of capital, but also for peculiar knowledge and training of a fundamental character. The cranberry grower must understand how to assure an adequate supply of water for flooding his bogs, must understand the nature of the insect and fungous enemies of the cranberry crop, must know something about cranberry fertilization and the packing, handling and storing of cranberries. The growers of this crop have been enabled to record progress largely because of their organization and the careful study of the needs of their industry. There are requests from them, as there are from fruit growers and others, for special service of a research character.

III

MEETING THE DEMANDS

The demand for special service has been met as far as practicable within the past year. Experiments have been in progress on the use and action of commercial fertilizers, means for increasing the availability of soil potash, means for increasing the recovery from nitrogeneous fertilizers, and means for increasing the nitrogen content of the soil with the aid of green manures. Soil investigations are being conducted on a field scale and also in cylinders and pots at the College Farm. Other fertility studies are being made in the experimental peach orchard at Vineland, N. J., and in a number of counties under the supervision of farm demonstrators. The study of lime problems has received much attention within the past year. Aside from comparisons of magnesian and non-magnesian lime in different amounts and for different crops, studies have been made in the laboratory on the influence which ground limestone of different degrees of fineness may have on soil microörganisms and on the rate at which limestone of different degrees of fineness may neutralize soil acidity. Inoculation studies with soil bacteria have been continued, especially in connection with the growing of soybeans. One of the notable results of the soil research at the Station is the method for making available the phosphoric acid of insoluble phosphates by means of the oxidation of sulfur. It has been demonstrated that sulfur, when mixed with soil, is changed by microörganisms into sulfuric acid. This fact has been known for several years. The director of the Station suggested in the fall of 1915 that a practical application be made of this knowledge in that sulfur, ground phosphate rock and fertile soil be composted together. A large number of tests made with different mixtures of sulfur, ground phosphate rock and soil have shown that the sulfuric acid derived from the sulfur actually does make available the phosphorus in the phosphate rock. The method has been outlined in scientific and popular papers, and is likely to prove of great practical value.

The entomologist and plant pathologist of the Experiment Station have been conducting investigations on the control of insects and plant diseases injurious to fruit, berries, vegetables, potatoes and greenhouse and ornamental plants. Gratifying progress has been made in the control of the strawberry weevil, in the control of pear blotch and of one of the troublesome celery diseases. Progress has been made also in other directions as recorded in the statements of the departments concerned.

Something has been added to the sum total of our knowledge by the investigations in the Departments of Dairy Husbandry, Animal Husbandry and Poultry Husbandry. Experiments have been carried on in connection with the use of milk substitutes for calves, and tests have been made of different mixtures for the purpose of determining the most economical methods of feeding dairy cows. The place of forage crops in economic pork production has been further studied, and earlier results have been confirmed. The self-feeder has demonstrated its utility in lowering the cost of pork produced under eastern conditions. A study has been made of improved types of forage crops and field crops, and likewise of farming in vogue in central and southern New Jersey. The farm management investigations of the Agronomy Department have been published in part in Bulletin 294 of the Station. Other bulletins on similar subjects will appear at a later date. Mention should be made also of drainage studies, plant breeding investigations, and the study of oyster propagation. These and other experiments and investigations have already borne fruit and give promise of contributing in a larger way to the different agricultural interests of the State.

In carrying on the investigational work of the Station the staff has been fortunate in having had placed at its disposal increased facilities. Trustees and friends of the College made available for use by the Horticultural Department of the Station a farm of 35 acres located on Ryder's Lane. This farm is to be used for the growing of vegetables as well as of fruit trees, and is a particularly welcome addition to the resources of the Station in that the soil of this farm is of a sandy loam and suitable for vegetable growing. Most of the land of the College Farm is not suitable for that purpose. A greenhouse laboratory has been built and occupied. This is to serve the needs of the Department of Botany and is to be occupied by the plant physiologist of the Station. Another greenhouse is in the process of construction. When completed, this will be used by the Department of Plant Pathology. The dairy herd of the Station has been increased by gifts and purchase. The director of the Station wishes at this time to thank Messrs. A. A. Cortelyou, Grant B. Schley, Bernhard Meyer, Percival Roberts and James C. Turner for gifts of dairy animals. These are thoroughly appreciated and will help the Dairy Department to build up a very creditable dairy herd for both the Station and College. Also, the herd of swine at the Station has gained in value both by purchase and natural increase. It is at present one of the best balanced station herds in the country.

Under the direction of the administrative officer and the editor of the Station, there is being published a technical journal known as "Soil Science." The establishment of this journal has made possible the more satisfactory publication of papers by soil investigators in this country. Formerly, soil research papers were published in European journals. Moreover, the establishment of the journal has given the Experiment Station and Agricultural College of New Jersey an opportunity to conserve more effectively the funds available for the printing of bulletins and circulars. "Soil Science" has now subscribers in nearly all of the States of the Union and in a number of foreign countries.

It is probable that two or three additional farm bureaus will be provided in the near future. The activities of the farm bureaus already established have met with favor in their respective counties. The farm demonstrators are not merely giving information on timely topics, but are also helping to crystallize public sentiment on questions which concern the entire agricultural industry. The correspondence of the Station has experienced further growth. The number of letters written by the extension specialists, farm demonstrators and members of the reseach staff was much larger than in the preceding year. Indeed, the volume of correspondence has grown to such dimensions as to demand a considerable expenditure for clerical services. Technical bulletins and circulars have been published. Their titles and date of publication are given elsewhere in this report. Educational exhibits have been shown at a number of local fairs as well as at the Interstate Fair at Trenton, N. J. The interest displayed in these exhibits and the correspondence of which they were productive show that such exhibits are educational factors of considerable moment. As usual, there were a large number of visitors at the College Farm and Experiment Station. Many of them came for the purpose of consulting members of the staff in person relative to farm problems. Others came to inspect experimental work now in progress. There were also many visitors at the experimental peach orchard at Vineland, N. J., and hundreds of persons attended the demonstrations given by the extension specialists of the Station in different localities of the State.

Limitations of the Station's Service

In applying the knowledge already accumulated in the field of agriculture, one finds certain limitations which can be overcome only with more or less difficulty. New methods must not

only overcome the conservatism of the farmers, but undoubtedly demand technical information which the farmer does not always possess. Thus, the introduction of new machinery, of new fertilizers, of new insecticides or fungicides calls for greater technical skill and training. In other words, as the business of farming grows more complicated, the successful farmer finds himself obliged to broaden his knowledge and to acquire a more fundamental education. It is obvious that the successful farmer of to-day must be a man educated in different directions and capable of understanding various technical problems. The service rendered by the Experiment Station finds its limitations among those of the farmers of the State whose education and experience are not in keeping with the most advanced agricultural thought.

The service which the Station would attempt to render finds its limitations also in the lack of working capital and in the lack of coöperation among farmers. That these limitations will be removed in time there is no doubt. Meanwhile, the various educational forces in agriculture will have to do their full share in preparing the farmer and his sons for coping with the problems which the future must bring. There are also limitations within the Station service itself in that facilities for research are not always adequate, nor are the equipment and staff always in keeping with the many questions which should be answered. There is danger in attempting too much. From the standpoint of research, it is much better that few problems be investigated thoroughly rather than many problems superficially.

IV

FUTURE PROGRESS

Better Education

Agricultural progress of the future will be determined by the progress of the educational forces and agencies in agriculture. Better education must be provided for the coming generation of farmers. We must have better rural schools. We must have agricultural courses in the rural high schools. There should be provided in the rural districts of the State secondary schools where agriculture may be taught as a vocation. Short courses in agriculture and movable schools can be and should be made more effective in their organization and scope. The organization of the agricultural societies should be encouraged as should be the reading of good farm papers and of good books on agriculture. Not least among the educational agencies is

travel. Better roads, the telephone and the automobile have widened the farmer's range of observation, and, to that extent, have added much to his education. The further expansion of the farmer's range of observation is to be encouraged and hoped for. This will be readily admitted by all who feel that new ideas and improved methods mean much in agricultural advancement.

Development of More Intensive Production

Specialization is one of the striking characteristics of New Jersey agriculture. Many years ago New Jersey was a livestock State. Later it was a general farming State and a dairy State. Now it is designated as the "Garden State." It's fruit growers, vegetable growers, florists, poultry keepers and certified milk producers seems to be holding their own with their brethren of other States. The values which express agricultural production in New Jersey are quite significant. The Census of 1900 credits New Jersey with an annual value of agricultural commodities produced of $26,000,000. The corresponding value in 1910 was $43,000,000. In 1915 it was $68,000,000, and in 1916 it is likely to exceed $80,000,000. This wonderful expansion in values has not been based on the increase of acreage under cultivation. As a matter of fact, the acreage under cultivation in 1916 was less than that of 1900 by about 300,000 acres. The increase in the value of agricultural commodities produced in the State has been due only in part to higher prices. More largely it has been due to larger yields per acre brought about by the more intelligent methods of fertilization and tillage. Specialization is to be further emphasized in the coming years. The farmers of the State will lay more and more stress on the production of crops of high commercial value. Soil fertility will be brought to a higher level, as will also average crop yields. But, as the methods of production are made more intensive, the danger from attacks by insect enemies and injurious fungi will also be increased. Fertilization problems will become less simple and the Experiment Station will be called upon to investigate the new problems that might arise and to offer technical advice on an increasing number of subjects. As coöperation in production finds a firmer place among farmers, as the transformation of more of the raw materials into finished products becomes more common, new questions and problems will be presented to the Station. There will be need of information on the canning of vegetables and fruit, the drying of

vegetables and fruit, the preservation of meat by curing, smoking, pickling, etc., and a number of other questions.

Provision for Larger Service

The larger service demanded from the Station will call for additions to the staff, additions to the acreage of arable land and additions to the buildings and equipment. It is far from the thought of the Director and his associates to ask for appropriations that may be premature. The need has already come, however, for buildings that could be used both by the College and the Station. The most pressing need is that of a horticultural building that should contain classrooms and laboratories, primarily for the purposes of instruction. This building should also contain laboratories and offices for the staff of the Horticultural Department of the Station. The need is also becoming felt more strongly for an animal husbandry building and a machinery building in which there could be stored agricultural machinery and implements to be used for instruction, demonstration and research purposes. After all, the appropriations made to the Station are in the nature of an investment, which, to judge by the long record of service, should return handsome dividends in the future as it has in the past.

V

STATION ACTIVITIES

Brief résumés of the activities of the several departments of the Station as submitted by the heads of these departments are herewith given. These will serve to furnish information concerning the research projects and other activities of the institution.

Chemistry

The department's activities have been confined mainly to the inspection work as required by the laws regulating the sale of fertilizers, agricultural lime, feeding stuffs and insecticides. During the year 2,278 samples were examined and duly reported on. These examinations required about 19,000 separate determinations.

FERTILIZERS.

Registrations by 131 manufacturers,	1,493
Samples received,	1,640
Samples analyzed,	1,018

The tonnage reports received during the fiscal year were as follows:

			Tons.
November,	1915.	Mixed fertilizers,	53,288.11
		Fertilizer materials,	5,459.28
April,	1916.	Mixed fertilizers,	61,368.88
		Fertilizer materials,	9,032.38
Total tonnage for the fiscal year,			129,148.65

On account of the unusual conditions of the markets, it was impracticable to prepare a schedule of values and, consequently, no valuations have been calculated for the materials that were examined within the period covered by this report. The samples that were examined consisted of the following:

Five hundred and sixty-five commercial fertilizers, 27 commercial fertilizers (duplicated), 45 commercial fertilizers (unofficial), 13 home mixtures, 208 fertilizer materials, 43 ground bone, 117 sundry materials. Total, 1,018.

Five hundred and sixty-five brands of mixed fertilizer were examined. All of these were accompanied by guarantees with one exception. The average of the guaranteed samples substantially satisfied the guarantees as given. A detailed study of the results, however, shows that the goods delivered were not satisfactory, only 122 brands fully satisfying every guarantee given, and, in addition, 233 brands substantially satisfying the guarantees. The remaining brands, or about 37 per cent, were deficient, 182 brands being deficient in one element, 26 in two elements, and one in all three of the elements. There were 1,406 deficiencies possible, and of this number 237, or 16.9 per cent, were found. This is the largest percentage of deficient brands found since 1908.

Some rebates have been paid by the manufacturers on account of the shortage found, but it is safe to say that a large sum of money has been paid by the purchasers for which no value has been received.

There were 139 deficiencies in nitrogen, and this is the largest number reported since the inspection work started. On account of the serious condition, the Chemist has called particular attention in the second fertilizer bulletin to the situation, and stated that inasmuch as it is not the duty of the State Chemist to enforce the law, the purchasers should make use of the reports which they receive in order to secure the plant-food paid for. He also stated the method that should be followed in such cases,

The bulletins issued were registration bulletin, No. 290, and the first fertilizer bulletin, No. 292. The second fertilizer bulletin is being prepared.

AGRICULTURAL LIME.—Forty-three manufacturers registered 87 brands. Thirty-five brands were examined and the detailed results, together with a list of the manufacturers and addresses, will be given in the second fertilizer bulletin.

COMMERCIAL FEEDING STUFFS.—Two hundred and ninety-four, or 26.6 per cent, of the brands did not satisfy all of the guarantees given. During the 1915 inspection 17.7 per cent of the brands were found deficient. The percentage of samples that was found deficient in protein and fat this year is about the same as reported last year. The poorer showing this year was due to the large increase in the fiber deficiencies.

INSECTICIDES.—Fifty manufacturers registered 198 brands of insecticides. Eighty samples were collected by our inspectors, 74 of which were examined. The composition of these samples was found to correspond to the guarantees given. A bulletin on the subject is to appear in the near future.

Horticulture

The test of different benching dates of carnations is completed, as are the lime studies with roses. Considerable progress has been made in the peach breeding work. Four hundred seedling trees were planted out in orchard form in the spring of 1916, and more than two thousand trees from known crosses were produced in the nursery last season, and will be ready for planting the spring of 1917. An additional lot of pits, more than two thousand in number, were secured as a result of the crossing work this past summer. These have been stratified and will be planted out in nursery form next spring. The Station will soon have a large number of seedling peach trees of known crosses for study.

The pruning experiments with peaches require much time for the recording of data. These experiments were started in 1912, and the trees have now produced three crops. The first two seasons' results have been written up and are now nearly ready for publication. The fertilizer experiments with peaches were begun at Vineland in 1907. Records of yields have been taken of each individual tree in the experiments, and furnish data for a bulletin which is to appear when time and funds will permit of its publication.

The pruning experiments with apples have been carried on since 1913, and records of considerable volume secured.

VEGETABLE WORK.—Through the generosity of trustees and friends of the College a 35-acre farm located near the College Farm was purchased in the spring of 1916. This farm is now being used for the development of instruction and investigation work in vegetable gardening. The soil is of a medium loam type and distinct from the red shale, the prevailing type in the vicinity of New Brunswick. The Station has been in need of a plot of land where vegetable work could be carried on under favorable conditions. It is hoped that the vegetable investigations at the New Jersey Station may be developed in keeping with the progress of the fruit investigations.

PROJECTS.—The following projects have been outlined: Fertilizer experiments with standard apples and dwarf pears and peaches; pruning experiments with apples, peaches and pears; variety tests of apples, pears, peaches, plums, grapes and small fruits; cover crop, breeding and spraying experiments with peaches; the study of dynamiting for tree planting; the study of peach yellows and little peach; soil, fertilizer, lime, moisture, breeding and bench construction studies with carnations; soil and fertility studies with roses and gardenias.

Animal Husbandry

Responsive to the continued interest in problems relating to pork production, the experimental work conducted by the department has centered around studies in the growing of forage crops and determining their relation to economical feeding. To meet the peculiar conditions that exist in this State, a series of experiments were planned to determine not only the most palatable mixture of green forage, but likewise to suggest conclusions relating to the crop that would supply forage throughout the season, and more especially at a time of year when it would serve the animals to the best advantage.

It is essential that a forage crop be palatable, that it yield abundantly, and that it be hardy enough to withstand not only unfavorable seasonal conditions, but also the tramping incident to foraging by the pigs themselves. While it has been generally assumed that permanent pastures meet this condition, our investigations go to show that it is important that areas given over to the growing of swine be plowed each year in order that the best results and the most efficient returns shall be obtained.

Rather than rely on any single forage crop to supply these requirements, our investigations prove conclusively that combination mixtures serve this end to the best advantage. Rape and sweet clover in combination with oats as a protecting crop, with red clover added to establish permanence, has many advantages. Rape alone is not especially palatable, neither does it grow as vigorously as when produced in combination with a legume. Furthermore, such combination mixtures simplify the selection of a concentrate, as corn is clearly the only supplementary feed that market pigs require when foraging on such a combination of forage. Soybeans in combination with rape and sweet clover furnished an excellent mixture, but has the disadvantage of being a relatively short season crop, as it is not practical to plant the soybeans early in the season.

More important, perhaps, than the problem of producing forage crops is the question of the selection of concentrates for feeding breeding, as well as market, pigs. The unprecedented increase in the cost of concentrates has complicated the problem of rations. Furthermore, the cost of labor has increased substantially, and the live stock farmer is confronted by the question as to whether even as efficient an animal as the pig can be relied upon successfully to convert high-priced grain into pork products at a profit, in view of the fact that it is a relatively long distance in marketing between the animal on the hoof and the animal on the hook, especially under conditions of distribution that prevail in this State.

Our experiments of last year pointed to the fact that the free-choice system would simplify the labor problem to a certain degree, and that the pig could be safely relied upon to select and balance his own ration, provided opportunity is afforded. It is interesting to note that the season's investigational work suggests that the use of the self-feeder shortens the growing and fattening period by at least 60 days, and that in the end this method has many advantages. It is evident, however, that the most economical use of forage crops does not obtain when pigs are given access to both the self-feeder and forage crops, but rather that they will prefer to rely upon the concentrates as a source of nutrient rather than to forage extensively in the field. It seems, therefore, important to limit the amount of grain supplied in connection with forage crop feeding until the animal has reached at least 100 pounds in weight, if the greatest economy is to prevail. In other words, while the self-feeder has proved its value in supplying feed to brood sows nursing pigs, and to mature market animals intended for fattening, it is an

extravagant means of feeding gilts intended for breeding or even market pigs during the entire cycle of their growing period.

Believing that more attention should be paid to cost of maintaining a breeding herd, a series of experiments were conducted with the object of suggesting a ration suitable for wintering brood sows. Endeavoring to confine such products to those produced on the farm, ear corn and alfalfa hay were used as a basis for such a ration. Finding, however, that brood sows fail to consume large amounts of alfalfa hay when supplied in racks, it was planned to grind the hay and supply it in the form of alfalfa meal. It developed that this was a practical solution of the problem. A 300-pound brood sow would consume scarcely more than one pound of alfalfa hay when supplied in racks, but when the hay was ground and moistened with molasses it was a regular occurrence to have a 300-pound brood sow consume at much as 3 pounds of alfalfa hay per day, and in this amount the hay could be relied upon to supply the bulk of her maintenance requirements. It was possible, therefore, to reduce the daily cost of maintenance for a 300-pound brood sow from 12 cents to 7 cents per day by the simple process of grinding the alfalfa hay and mixing it with molasses, and supplementing this combination with a little hominy and tankage chop. The brood sows gained regularly on this mixture, settled promptly when mated, farrowed strong vigorous pigs, and went through the nursing period with more flesh than in cases where the corn and alfalfa hay were relied upon entirely as a source of feed.

During the coming winter we shall run these experiments in duplicate, and hope to verify the figures, which give promise of suggesting more economical and practical rations for brood sows.

With Black Strap molasses at 24 cents a gallon, it seems doubtful whether it can be used as a substitute for corn or hominy meal. Under average conditions, when it sells for 8 or 9 cents a gallon, it is clearly evident that it would serve in reducing the cost of weight increase where it was used as a substitute for corn or hominy and mixed with alfalfa hay and tankage. It is interesting to note the results of the experiments conducted with 10 gilts, 5 of which were fed molasses and alfalfa hay exclusively from the time that they were weaned until after their first litter of pigs had been weaned. Their gains were made at slightly more than 3 cents a pound less than those obtained with the 5 gilts fed corn, tankage and alfalfa.

Considerable difficulty was experienced during the year with hog cholera. In spite of the fact that the entire herd was subjected to the serum simultaneous method of treatment under

conditions that should avoid infection, losses were frequent and doubtful as to cause. That the double treatment under average conditions does stunt the growth of pigs seems well supported by conditions that prevailed in our herd during the past year. The claim that suckling pigs from immune sows carried such immunity during their nursing period was not verified in the Station herd, for losses were recorded among suckling pigs nursing immune sows, although the sows themselves were perfectly healthly. It would seem that, if the double treatment checks the vigor and vitality of the animal and prevents him from making normal gains during the early growing period, its general adoption should be discouraged.

The breeding herd has reached a stage as to numbers and quality that should allow constructive work in breeding and economy in production. It is hoped that the question of costs in production may be worked out next year, although the abnormal conditions prevailing at the present time may discourage such an undertaking.

Poultry Husbandry

The work in the Poultry Department during the past year consisted of carrying on projects which have been under investigation for a number of years; special attention being given to feeding, incubation and breeding problems. The amount and best sources of protein in poultry rations have been studied with great detail. Certain incubation problems, especially the cause of death of chicks during the latter stages of incubation, are being investigated definitely in a series of projects which will cover a number of years. The work on breeding for fecundity and the inheritance of egg-shell color and plumage pattern are progressing satisfactorily. A wonderful opportunity has been presented for the securing of a great mass of valuable data pertaining to egg production and the inheritance of this character, together with correlation observations pertaining to egg production and the physical appearance of birds, through the Poultry Department's activities in supervising the Vineland International Egg Laying and Breeding Contest, which starts November 1 of this year. Now that the poultry farm is approximately completed, more time and energy from the department staff members can be centered upon research problems and the detail of research work will be less interfered with than during the past three years.

Dairy Husbandry

The work of the Dairy Department for the past year has been practically a continuation of the work carried out during the few previous years. This naturally divides itself as follows:

1. The herd—including changes in the herd, records of milk production, and cost, and data in connection with the cost of raising heifers and calves.
2. Cow testing associations.
3. Advanced registry work.
4. Testers' license, and Babcock test glassware regulations.

THE HERD.—The most gratifying features in connection with the work of the Dairy Department for the past year has been the marked increase in the average milk production of the animals in the herd, and the general improvement in the health of the herd. The average production per cow for the year just closed was 9,505.9 pounds as compared with 7,671.9, an increase of 1,834 pounds per cow. This increase may be attributed to heavier feeding and to the elimination from the herd of several animals which were found to be unprofitable. The loss due to contagious abortion, which was so prevalent in the herd a few years ago, has been checked and at the present time the herd is practically free from this trouble. Several pure-bred animals have been added during the year and, with a natural increase from these and other animals in the herd, it should be only a matter of a few years when all the grade animals can be eliminated. Owing to a heavy increase in the cost of concentrates, the cost of producing milk is considerably higher than in previous years. This same statement applies to the cost of raising heifers and calves.

COW TESTING ASSOCIATIONS.—The three cow testing associations which were in operation last year have been reorganized and, in addition, two new associations have been formed. The associations now in operation are located as follows: Sussex County, two; Salem County, one; Cumberland County, one, and Bergen and Passaic Counties, one.

Early in the year, Mr. John W. Bartlett was appointed Extension Specialist in Dairy Husbandry, and the development of this work has been placed under his supervision. Interest in this work is increasing, and it is quite possible that several more associations will be organized during the coming year. Records of the production and cost of feeding the 2,500 or more cows now under test are being kept by this department. When deemed sufficient, these records will be compiled for the purpose of comparing the cost of milk production from year to year.

ADVANCED REGISTRY WORK.—The number of tests supervised by this department for breeders of pure-bred cattle in this State shows a slight increase over that of the previous year. In keeping with the policy of the department of former years, records of the production, amount and cost of feed of all animals under test have been kept. It is the intention of the department to compile these records as soon as sufficient data has been gathered, and some valuable information may be obtained therefrom.

TESTER'S LICENSE DIVISION.—The law regulating the weighing, testing and purchasing of milk and cream (Chapter 31, Laws of 1916), passed at the last session of the State Legislature, went into effect September 1, 1916. A copy of the law and full information concerning the rules and regulations to be complied with are contained in Circular 62, prepared by this department. A copy of this circular will be sent to any person, on request. To date, 41 applicants have taken the Testers' License Examination, and of this number 34 have been successful. Two thousand and nineteen pieces of glassware have been inspected, 0.7 per cent of which was found inaccurate. As yet a sufficient opportunity has not been afforded to enable the department to offer any comment as to the working of this law.

Seed Control

The work of the Seed Laboratory during the year has been similar in nature to that of preceding years, inasmuch as it has been an attempt to carry out the provisions of the law and to make the service rendered as valuable as possible. While the character of the work has not materially changed, the quantity has increased in proportion to the demand. Although the total number of samples received for test represents an increase of only 20 per cent over the number received within the preceding year, the increase from the first year is over 100 per cent.

During the year the seed analyst has prepared for publication circulars on weed control and describing the new seed law, and a bulletin giving the results of tests of official samples for 1914–1916, with pertinent information and various news items dealing with seed problems.

The Seed Laboratory was enabled to make a study of the crimson clover seed offered in 1916 and to make public the resulting information previous to the time of purchase. It is believed that information given at this time is infinitely more valuable than any results that may be published after the seed is sown and crops harvested therefrom. Unfortunately, however, such pro-

cedure is not generally possible owing to trade conditions and limitations of labor and funds. The new seed law, effective November 1, 1916, will accomplish practically the same result, inasmuch as agricultural seeds must be labeled with certain statements as to quality.

The quality of the seeds examined during the year calls for no particular comment. Instances of loss due to low purity and germination might be cited, but in each case available measures of protection were not adopted in due time.

Observations on the development of certain strains of alfalfa in different parts of the State have been reported. While these observations are too limited to be definitely conclusive, there are certain suggestive features worthy of some future attention.

Weed plants have been identified and advice given as to eradication. It would seem well worth the expense to devote a thousand dollars or more to the study of weed problems. A portion of this should be available for educational work along this line.

Agronomy

The Agronomy Department is charged with two separate lines of work. The first of these embodies farm crops, such as the grains, and forage crops commonly grown in the State; the second embraces farm management, including farm organization, cost accounting, profits derived from different types of farming and labor efficiency.

CEREALS.—During the past year 30 different varieties of oats, 34 varieties of wheat and 2 varieties of barley have been tested and studied. This is to meet the constant demand made by the farmers for the best variety of these different grains for growing in New Jersey. When the most desirable varieties of corn, oats and wheat are found with their adaptations, then these crops can be improved through selection for superior strains. By isolating proper varieties and improving them through selection, it should be quite possible to increase the yield of the corn crop 10 to 30 bushels per acre for the State as a whole. Since corn is a crop which cannot be satisfactorily imported from outside the State, it is necessary to develop varieties and strains particularly adapted to the State as well as to the different localities in the State. This work should include varieties of both grain and ensilage corn. When we consider the the value of this crop alone is 11 per cent of the total value of the agricultural products of the State, its development warrants more attention.

FORAGE CROPS.—The forage problem for the State is becoming more acute with the high cost of feed. During the past year 44 different grasses and legumes were grown on a small scale and their adaptations noted. Methods of alfalfa culture by seeding in rows, broadcast and with timothy, were studied to determine their practical value. Sudan grass was grown in comparison with the millets.

FARM MANAGEMENT.—The major portion of the activities of the department was centered upon farm management work. Survey records obtained from Monmouth County were classified and records of farms classed as potato farms were completed, tabulated and published as Bulletin 294 of the Experiment Station. The tabulation of the records secured from the general farms is almost complete and ready to be published in bulletin form. Work such as this forms a definite and authentic basis for the proper organization of a farm. It seeks and finds successful farms, successful crop rotations, successful farm practices, successful farm units, as well as successful farmers. Information such as this, obtained from all the counties in the State, would form a basis for the proper type of farming and the proper farm organization for each locality. Each farm as an individual is considered as a miniature experiment station, and information from a larger number of these miniature experiment stations is vast in possibilities and value. It shows what actually is taking place on the farms of the State, as well as what should take place. It shows the proper type of farming that should be followed in each locality, and serves as an accurate guide for the future development of the farms in New Jersey.

COST ACCOUNTING.—Cost accounting has been started in three counties. This is commanding wide attention from farmers all over the State. To-day the increased cost of farming makes it necessary for the farmer to keep records of his business.

Agricultural Extension

One of the strongest features of our extension work is the organized county farm demonstration service that is being rendered in 11 counties of the State. The county superintendent of farm demonstration is a member of the College staff, and that makes him a representative of the College and Station within his county. It gives him direct touch with the research departments of the Station and enables him to be a medium through which any farmer wanting assistance can reach the Station quickly. The county farm demonstrator is not a teacher, but a

coöperator, working out local problems in connection with those who are vitally interested. He is under the direction of representative men in the county and is the means used by them for the promotion of its best interests. The work of the 11 organized counties is in good shape, and farmers in 4 unorganized counties are asking for the assistance of a farm demonstrator.

The Extension Division has specialists in farm crops, fruit growing, market gardening, poultry husbandry, dairy husbandry, soil fertility, home economics and boys' and girls' club work. These specialists assist the county demonstrators in organized counties and carry on as much work as their time will permit in other counties. The demand for such service is far beyond our ability to supply. Some increase in appropriation last year has enabled us to expand the work, but many requests necessarily cannot be met.

Special mention should be made of the work in home economics, girls' canning clubs, etc. Our young people are easily interested in industrial work, and should be given instructors and leaders. It would be easily possible to increase the membership of home making clubs, canning clubs, corn clubs, pig clubs, etc., ten-fold if we had an adequate force for organization and leadership.

The effectiveness of our extension work will be increased by its coördination with the work of the new Department of Agriculture, at Trenton. In organized counties the farmers' institutes are placed under the direction of county superintendents of farm demonstration, who are guided in turn by representative men and women of the county. The institutes are gaining in effectiveness as a result. Many county boards of agriculture will become the advisory committee of farm demonstration offices, and gradually we shall have entire unity in all of the State's work in agriculture. We shall need annually some increase in State appropriation to take care of more organized counties, and especially for the development of work in home economics and boys' and girls' clubs. The degree of success that has been attained is due to the loyal support of the members of the grange and other progressive people in the rural life of New Jersey.

Soil Chemistry and Bacteriology

Nitrogen Availability Project.—The work under this project has been continued in accordance with the plan which has been followed for the past few years. The timothy on Plots

1 A to 20 B has been harvested, samples prepared and the nitrogen determinations made. However, the results have not been brought together for comparison.

The cylinders of Group L for the most part bore an excellent crop of wheat and the data in connection with this are being brought together. Next year's results will complete the fourth 5-year period for this experiment.

A crop of barley and a residual crop of buckwheat were grown on cylinders of Group N and nitrogen determinations have been made on all these samples. A report on this work is included in this year's annual report. The results are, in the main, in accord with results secured in previous years but there is better agreement between duplicates than heretofore.

Nitrogen Accumulation and Utilization Project.—This includes the 320 cylinders of Group N, field plots 21 to 48, 49 to 56, 65 to 71, A to F, M to R, and also certain pot experiments. Crops were successfully grown on all cylinders and plots, and these have been carefully weighed and samples prepared for analysis. Many of the nitrogen determinations have already been made. On the clyinders leguminous green manure crops as a source of nitrogen have given excellent results. With but few exceptions they have proved superior to nitrate of soda (160 lbs. per acre) and stable manure (15 tons per acre once in 2 years). Very satisfactory agreement has been obtained between duplicate cylinders.

In the lime and rotation experiments—field plots—the limed plots have not only given a larger yield than the check plots, but they have in nearly all cases given a crop with a higher percentage of nitrogen in the dry matter than the check plots. A careful examination of the roots of soybeans from limed and unlimed plots show a decidedly larger number of nodules on the roots from the limed than from the unlimed plots. This would indicate better inoculation, and, therefore, a larger supply of available nitrogen for the plant, which would no doubt account for the higher percentage of nitrogen in the dry matter from the limed plots.

The continuous wheat plot, with a leguminous crop as a source of nitrogen, yielded almost twice as much grain and more than twice as much straw as the corresponding plot without a legume. Also there was recovered from the legume plot more than twice as much nitrogen as from the non-legume plot, and the dry matter of the former contained a higher percentage of nitrogen than the dry matter of the latter.

SULFUR OXIDATION PROJECT.—A large amount of laboratory work has been carried out to determine to what extent sulfur is oxidized in the soil by micro-organisms. Also, much work has been done to determine to what extent the sulfuric acid thus formed makes available the phosphoric acid of the rock phosphate. Work has been carried out by means of laboratory and pot experiments. The results so far are encouraging.

SOIL FUNGI PROJECT.—An attempt is being made to determine whether soil fungi play a part in the oxidation of sulfur.

SOIL BACTERIA PROJECT.—Counts have been made on samples from certain of the field plots and the ammonifying power of soil from plots receiving different lime treatments has been determined.

SOIL PROTOZOA PROJECT.—With reference to this project, there appears to be nothing definite to report at this time.

OTHER ACTIVITIES.—In the case of the alfalfa experiments on plots *E, F, G* and *H,* the yield of hay has increased each year since the first crop in 1914. With only a few exceptions, the yield has increased with increased applications of lime. The maximum yield was 7,640 pounds for three cuttings, on Plot G, in 1916. The maximum yield in 1914 was 4,500 pounds. Attention should also be called to the fact that, with only slight exception, the percentage of nitrogen increased with increased application of lime. For example, the average percentage on Plot E, check plot, in 1916 was 2.45 per cent, while the average percentage on Plot H, 4,000 pounds of ground limestone per acre, was 2.89 per cent.

Lime has also resulted in a larger yield of soybeans per acre and likewise a higher percentage of nitrogen in the beans. Counts were made of the nodules on plants from limed plots and also from unlimed plots, the former giving an average of 83 nodules per plant and the latter 50 nodules per plant. This would appear to strengthen the belief that lime favors those organisms that live in the roots and take nitrogen from the air and may also in part explain the higher percentages of nitrogen in the dry matter from limed plots.

There have been analyzed about one hundred samples of soil from the Freehold Area. The results of these analyses have been put into shape for publication. Also about one hundred and fifty samples of soil from the Camden Area have been analyzed and the results tabulated, but the material has not yet been prepared for publication.

The pot experiments with greensand marl indicate that soybeans, at least, are able to make a very good growth and form pods with no other potash than that furnished in a slowly available material. However, further work must be done before definite conclusions can be drawn.

Botany

The work for the past year has been under the three following projects: heredity, environment and toxicology.

Under "heredity," the chief subjects are beans, corn, eggplants, okra, peppers, squashes and tomatoes, and the end sought is a better understanding of the laws of plant breeding. With beans, both crosses and hybrids are considered, and of the latter the combination between the garden varieties and the scarlet runner are most promising. These hybrids offer, among other things, an opportunity to study the inheritance of prolificness and of partial sterility.

The work with corn embraces the inheritance of the texture of the grain between the soft or flour kinds and the sweet and flinty sorts, for which purpose the corn of the Hopi Indians, with its chalky endosperm, is being bred with varieties of pop corn. Attention is being paid to the character of the tassel in its possible correlation with the form of the ear, and attempts are being made to isolate a strain of crossed corn that will show but comparatively few grains upon the normally-sized cob with the hope of determining the behavior of such nonprolific strain in breeding with ordinary corn.

Among eggplants the breeding is continued between various kinds for the purpose of gaining information as to the behavior of the quality of bitterness in breeding. An absolutely spineless strain seems to be in sight, which may prove of much practical value.

The peppers have been carried forward into the fourth generation and here it is learned that there is a close adherence to type. There is very little indication that the original parental forms are to be obtained, although the number of specimens of a single cross is among the thousands. Still further evidence has been obtained in favor of the opinion that there is some linking together of characters that are common to one or the other of the parents. Work is progressing upon the securing of nonprolific strains for purposes of breeding.

Tomatoes are now being bred chiefly for the purpose of determining whether permanent differences exist between the true

reciprocals, and to this end extreme types are being bred and the reciprocal offspring studied along parallel lines.

Under "environment," the work is divided into two groups: first, that which concerns the position of the part in (or upon) the plant; and second, the difference produced in the plant by varying amounts of heat, light and moisture. A study is in progress as to the relation of position upon the plant to size of pod in peanuts, beans, etc., and associated with this is a consideration of the relation of place in the pod to size of seed. For example, the records show that for scarlet runner the seeds of 2-seeded pods are heavier than those borne in the 3-seeded pods, and the weight decreases quite uniformly as the number of seeds in the pod increases. Experiments are under way to determine whether size of seed is an index of value for plant production. In like manner, it is being shown that the basal seed is the smallest and one near the tip the largest in the pod.

Researches concerning the physical environment of the plant are chiefly in connection with the greenhouse. In a study of the influence of soil temperature upon seeding corn, it was found that a summer temperature (25° C.) as compared with that of late autumn (12.50° C.) yield 63 per cent higher viability, while the lower temperature gave three times as much variability in size among the plants.

Under "toxicology," the researches consider the influence of different strengths of four phosphatic salts of calcium, potassium, sodium and ammonium upon seedlings of Wilson soybeans. Associated with this work is a study of the effects of different strengths of single salts in stated amounts upon the germination of several kinds of seed.

The effect of surface films of Bordeaux mixture upon the transpiring powers of tomato leaves has been studied in the open, and it was found that the transpiring power of treated leaves is nearly a quarter more than of untreated leaves and is greatest near the middle of the day.

During the past year a new laboratory has been built adjoining the greenhouse, which greatly facilitates the work in plant physiology.

Entomology

Investigations are in progress on the influence of atmospheric moisture upon insect metabolism, the methods of controlling the strawberry weevil, apple aphis, false cabbage aphis, pear psylla, the efficiency of certain types of covers for wintering bees, the food preference of the common house or typhoid fly, and the problems connected with mosquito control.

Influence of Atmospheric Moisture Upon Insect Metabolism.—Decrease in atmospheric moisture appears to shorten the pupal period in both the bean weevil (*Bruchus obtecus* Say) and the angoumois grain moth (*Sitoroga cerealella* Oliv.). It appears also to shorten the period from beginning to maximum emergence. Decrease in atmospheric moisture appears to shorten the length of adult life in the case of the moth and to lengthen it in the case of the beetle, although the differences in this instance are not very pronounced. Decrease in atmospheric moisture lengthens the period occupied by the life cycle in the case of the bean weevil. It decreases the reproductive ability and when 20 per cent or below, absolutely prevents reproduction by destroying the larvæ before they are able to penetrate the beans. The optimum of atmospheric moisture for the bean weevil metabolism from the standpoint of direct effect appears to be very close to 100 per cent, but inasmuch as this degree of humidity promotes the growth of destructive fungi the optimum must be placed somewhere between 75 per cent and 100 per cent at a point where the fungi are unable to develop. Storage of beans in an atmosphere with moisture of 2 per cent or less appears to preserve them perfectly from the attack of the bean weevil.

Strawberry Weevil.—The rather remarkable results obtained last year in the control of this insect by the use of mixtures of powered arsenate of lead and sulfur led to a repetition of the dust this year. The experiments were carried out in 3 different counties and on at least 2 farms in each case. The work at Cologne on the farm of Mr. William Oeser, because of greater care in the application of the mixtures and in the taking of data, is the one from which the quotations will be given. The varieties concerned are "Heritage," "Champion" and "Doris." Check plots were left on each side of each of the plots treated with the mixtures. Three treatments with powdered arsenate of lead 1 part, and sulfur 5 parts, gave 2,442 quarts per acre as compared with an average of 832.5 quarts on the checks. Powdered arsenate of lead 1 part plus sulfur 1 part gave 2,604 quarts per acre as compared with an average of 1,072 quarts on the checks. Powdered arsenate of lead alone gave 1,106 quarts per acre as compared with an average of 763 quarts on the checks. Sulfur alone gave 1,313 quarts per acre as compared with an average of 831.5 quarts on the checks. Thus the first mixture is seen to give an increase of 1,610.5 quarts per acre, the second mixture 1,532 quarts, the sulfur alone 481.5 quarts, and the lead alone 343 quarts. On the

basis of 8 cents a quart, the average selling price for good berries in that section, the gain chargeable to the treatments is for the first mixture $128.84, for the second $122.57, for the sulfur alone $38.52 and for the lead alone $27.44. Inasmuch as the average cost of treatment is about $4.00 per acre for the first and $8.00 for the second, the net gain per acre is not far from $100.00. The results from the 1 to 5 mixture are, of course, the better of the two, and both mixtures are much more effective than either of the two substances of which they are composed.

APPLE APHIS.—The species principally concerned is *Aphis sorbi* Kalt. At the orchard of Mr. John H. Barclay near Cranbury the aphis hatched the day before the completion of the spraying with winter-strength lime-sulfur would have been necessary to prevent injury to the buds and prevent the lice from finding shelter against the treatment. At the J. L. Lippincott orchards at Riverton hatching took place seven or eight days before the same stage of bud development was reached. At the Barclay orchard it was necessary to apply the winter-strength lime-sulfur before the aphis hatched and to follow the hatching of the aphis with a treatment of tobacco extract, soap and water. At the Lippincott orchards it was possible to use the winter-strength lime-sulfur together with the tobacco extract. In a set of experiments relating to this matter it was found that the most efficient work followed the application of the winter-strength lime-sulfur during dormancy and the tobacco extract and soap at the green bud stage. It was found also that the use of "Scalecide" after the aphis hatched destroyed 50 per cent of the buds.

FALSE CABBAGE APHIS.—This species was recognized for the first time in New Jersey this fall, but there is evidence to show that it has been present for a number of years and confused with other species. It is a pest of considerable importance on turnips in the Freehold district. It infests the under sides of the leaves and the drooping habit of the turnip plant renders its destruction extremely difficult. An apparatus for lifting the foliage and exposing the louse to a spray of tobacco extract, soap and water was devised and tried out. This apparatus was attached to an Iron Age potato sprayer.

PEAR PSYLLA.—This species has been troublesome in Kieffer and Bartlett orchards in the southern half of the State. Experiments during the past summer in the J. L. Lippincott orchards at Riverton indicate clearly that the single spray application of winter-strength lime-sulfur just before the flower buds open for

destruction of the egg will not control the insect in an entirely satisfactory manner, where in the previous year no attempt at control has been made. The results of the experiments also show that three treatments—scraping, dormant spray and pre-blossom spray—are effective under these conditions. It may also be said that similar results were obtained in the Richdale orchard at Phalanx, New Jersey, the preceding year.

WINTERING BEES.—This investigation is concerned with types of insulation. It was found that the C. H. Root cover, which so far as we know was devised and manufactured by Mr. C. H. Root of Red Bank, is more effective in preventing sudden and sharp changes in temperature, large consumption of stores and in increasing early brood rearing than the quadruple cover with its much heavier packing. It also appeared that the saving in stores and the increase in brood is ample to pay for a large part of the cost of the case in a single season.

FOOD PREFERENCE OF THE COMMON HOUSE OR TYPHOID FLY.—(1) Glucose, fructose, galactose, maltose, lactose, sucrose, starch and dextrin were not very attractive to house flies. Lactose and dextrin caught the largest number of flies, starch the least. Sucrose was consistenly a poor bait. (2) The acids and alcohol lured flies in the following order: 4 per cent amylic alcohol (tech); 10 per cent acetic acid; 10 per cent amylic alcohol (tech); 4 per cent ethyl alcohol; 10 per cent ethyl alcohol, and 4 per cent acetic acid. Succinic and lactic acids showed some attractive quantities in two experiments. (3) Maltose, lactose, sucrose and dextrin in 4 per cent solutions of amylic alcohol, ethyl alcohol and acetie acid were more frequently visited by house flies than the corresponding aqueous solutions. Maltose and dextrin solutions were more effective than lactose and sucrose. The order of response to the alcohols and acetic acid was the same as in (2). (4) Crude gluten from wheat flour, consisting largely of gliadin and glutenin, was not attractive. Solutions of the water-soluble portion of wheat flour, with or without the starch in suspension, were decidedly attractive. (5) Several experiments with milk indicate that fat-free caseinogen is attractive while butterfat (ether extract) is not. (6) Experiments suggest that aqueous solutions of molasses to which sodium arsenite and amylic alcohol (tech) are added have considerable value as a poisoned bait for house flies. The water-soluble portion of wheat flour containing starch in suspension also gave good results with the same additions.

MOSQUITO INVESTIGATIONS AND CONTROL.—Our salt marsh drainage methods have been standardized and new ones intro-

duced. In so far as possible the narrow salt marsh trenching is now laid down in such a fashion that all ditches have strong tidal outlets—no trench is more than one-quarter of a mile in length unless it has more than one outlet—and the trenches are so connected as to form a circulating system. Low-lying and shut-in marshes near large cities of population have been increased in substantial dikes and outletted through sluices and tide gates. When the nature of the outlet has demanded it, centrifugal pumps have been installed. A new salt-marsh drainage machine has been invented and the price of ditching thereby materially reduced. The invention is the work of Mr. H. I. Eaton, chief inspector of the Atlantic County Mosquito Commission. Our knowledge of the habits of mosquitoes has been increased by (1) the determination of the type of wind on which the salt-marsh species travel—warm winds of high moisture and low velocity (10 miles or less per hour), and (2) the determination of salinity as a factor which governs the geographical distribution of the breeding of the two principal species of salt-marsh mosquitoes—low salinity (8 per cent or less) favoring *A. cantator* and high salinity (12 per cent or more), favoring *A. sollicitans*, and (3) the determination of rather extended migrations of the house mosquito (*C. pipiens*)—the distance covered being in some instances 2.5 miles. Our knowledge of the effect of possible larvicidal substances has been increased by the testing of sodium hydrate, sodium sulpho carbonate, borax, copper sulfate, iron sulfate, pyrethrum, nicotine, quassia, hellebore, ginger, pyroligneous acid, carbo-sul, pyridine, cresol, lyso, phenol (crude), a mixture of pyridine, xylol and rosin, and different samples of oils furnished for the purpose by the Standard Oil Company. Five hundred thousand linear feet of salt-marsh ditching has been thoroughly cleaned and the obstructions removed from all of the rest on the Atlantic Coast. The State Experiment Station has completed the cutting of 745,105 linear feet of new salt-marsh ditching and the counties have cut 2,543,713 linear feet of salt-marsh ditching. These counties have patrolled approximately 95,000 acres of salt marsh throughout the last mosquito-breeding season, covering a coast line of 125 miles. They have patrolled approximately 314,000 acres of upland, destroying the fresh-water mosquito breeding as it was found. They have afforded a good measure of protection to one and three-fourths millions of people. The total cost of the operation, aside from the work done by the State Experiment Station, which was paid for mainly from last year's funds, is less than $216,000.

Our project list is as follows: mosquito investigations; soil-infesting insect investigations; peach borer investigations; potato flea beetle investigations; climate and insect investigations; strawberry weevil investigations; hickory bark beetle investigations; orchard plant lice investigations; house or typhoid fly investigations, and miscellaneous investigations. Under miscellaneous investigations, we have included false cabbage aphis, the pear psylla and bee wintering. It is proposed, in the future, to follow certain especially important lines, such as climate and insect, mosquito and house-fly studies from year to year and to go into the phenomena connected therewith to the greatest possible extent, and at the same time to investigate certain phases of the more seriously injurious species at the particular time that they are most abundant. All investigations, except those relating to mosquitoes, are supported with the Hatch funds.

Plant Pathology

During the past year the correspondence of the department has been very heavy and it has been impossible to do as much in the way of field work as in preceding years.

The attention of the department has been called to 225 diseases of agricultural crops, some of which are of considerable importance.

The experimental work has been along the following lines:

1. Work has been continued on the influence of sulfur in the control of potato scab. This work has been supported by a fellowship established by the Union Sulphur Company of New York City. The fellowship has expired and the work has been discontinued. The results indicate that the application of sulfur to the soil is beneficial under certain conditions, especially those in which it is desirable to continue the planting of potatoes in the same soil year after year. The results of this work for the past year will be incorporated in the annual report and the results for the past three years in a manuscript for a bulletin. A resumé of the results will be published as a circular of the Station.

2. A long series of experiments has been conducted on the treatment of foliage diseases of potatoes. The results in different parts of the State are extremely variable, but it appears that spraying of the late crop of potatoes in South Jersey can usually be carried on with profit. The results of this work also for the past year will be submitted in circular form.

3. The department has also conducted a number of experiments with diseased and healthy seed potatoes at the College Farm, the seed having been furnished by the Maine Agricultural Experiment Station, the United States Department of Agriculture and from many sources in New Jersey. This line of work should be continued for a number of years.

4. Experiments are being conducted on the control of the various diseases of the celery in Bergen County. These experiments have involved soil sterilization, and, while the results are very promising, the importance of the celery crop in New Jersey is such as will justify a much more extended line of experimental work.

5. Experimental work is also in progress on the control of the foliage diseases of celery, and the results have been very gratifying.

6. Studies are being made on the control of foliage diseases of tomatoes at Salem, New Jersey. This work is in coöperation with the United States Bureau of Plant Industry and the H. J. Heinz Company. The results are encouraging, but many difficulties, beyond control, seriously interfered with the work. The tomato industry is of very great importance, and the control of the disease is the most important factor in tomato production at the present time. The nature of these diseases is such that it will probably require a long period of study to solve the problems in hand satisfactorily. It is very probable that arrangements may be made for a continuation of this work in coöperation with the United States Bureau of Plant Industry.

7. For a short period last summer the department continued its studies of the brown blotch of the pear. Very interesting data have been accumulated, and it is recommended that arrangements be made whereby similar studies may be carried on in the summer of 1917.

8. A manuscript on the parasitic fungi of New Jersey is almost ready for publication. The work will be continued from year to year with the idea of publishing supplements either as independent bulletins or as a part of the annual report.

Many studies have been made of problems, the results of which will be published from time to time.

Epidemics.—There have been several plant diseases of sufficient importance to be classed as epidemics. They are listed in the following paragraphs:

Peach yellows and little peach were much more severe than for many years past. It is to be regretted that it has been found necessary to discontinue the distribution of the bud wood to the nurserymen of the State. It is believed that there is no better method of controlling this disease than for the State to furnish bud wood from healthy trees to the nurserymen, and, where possible, to the growers.

The mosaic disease of tomatoes has been exceptionally severe, and was undoubtedly a great factor in the reduction of the yield.

Mosaic disease of peppers was very severe, but its importance is not recognized by many growers. Mosaic, leaf roll and Rhizoctonia of the potato were the cause of heavy losses. The early blight of the celery was the cause of heavy loss in celery-growing localities. Fire blight of the apple and pear was epidemic, but not so severe as in 1915. Many complaints have been received concerning trouble with shade trees, but, for lack of assistance, these problems could not be investigated.

Problems for 1917.—The following is a list of problems for 1917:

1. A continuation of the study of diseases carried in seed potatoes (Plot work at the College Farm).
2. Diseases of tomatoes.
3. Diseases of celery.
4. Injurious effect of fungi on plants.

5. Diseases of ornamental plants.
6. Diseases of orchard crops, especially the brown blotch of the pear.
7. Crown gall and other abnormal root growths.
8. Soil sterilization.
9. Diseases of beans along the line of developing resistant strains.

NEEDS OF THE DEPARTMENT.—The demands of farmers for personal inspections of growing crops and the heavy correspondence make it desirable that an associate plant pathologist be appointed. He should be in a position to carry on a considerable amount of this work. He should be especially interested in truck crops as these will demand a great deal of attention in the very near future. There is also need for a well-trained man, capable of distinguishing diseases which have very similar symptoms, but which require different treatment, to direct demonstration work. Such a man would keep in close touch with the problems of the State and would prevent many failures which are now the result of a confusion of diseases which present similar external symptoms. He would also tabulate the results of the control work through the State in a way that would be advantageous to all parties concerned.

The necessity for study on disease of tomatoes and eggplants is very urgent.

INSPECTION WORK.—The inspection work under the direction of the State Department of Agriculture has been very satisfactory. The most important development in this line of work has been the finding of the blister rust of the white pine in New Jersey. It would now appear that the situation is well in hand, but the conditions in other States lead the writer to believe that the white pine will be wiped out in the same manner as were the chestnut forests.

The Experiment Station Library

The Experiment Station Library is conducted as a branch of the Rutgers College Library. There are now approximately five thousand bound volumes in the library, and a large amount of unbound material in the form of bulletins, circulars and reports of the various experiment stations and of the United States Department of Agriculture, as well as the leading scientific journals relating to agriculture, current farm papers and periodicals, State newspapers and various other publications. An effort is made to keep two complete files of the publications of the State experiment stations, the State departments of agriculture and the United States Department of Agriculture. Considerable time has been spent in an effort to secure missing numbers to complete

the files up to date preparatory to having the various series bound. About 500 volumes of these bulletins, circulars and reports have been bound during the past year. At present there is an equivalent of about 500 volumes of unbound material of this class alone awaiting completion before sending to the binders. Acknowledgment is due the directors and librarians of the different experiment stations who have so readily coöperated in furnishing publications which were missing from the files. Also, a large number of unbound publications which were needed to complete some sets were presented to the library by Dr. Jacob G. Lipman, Dr. Byron D. Halsted, Mr. James Neilson, and the late Dr. Julius Nelson. The State Department of Agriculture contributed over one hundred bound volumes of various reports and some valuable unbound bulletins.

An effort has been made to complete the various sets of livestock record books; and, through the courtesy of the different record associations, a number of sets have been completed to date and others added to materially. A new card index of the publications of the United States Department of Agriculture was purchased. Considerable unbound material was moved from the College Library and is being arranged for use.

The library records show that approximately 800 bound volumes and unbound publications were loaned during the year. About 75 volumes were borrowed from the Library of the United States Department of Agriculture and the Library of Congress, Washington, D. C., for the use of the experiment station workers.

The library is now badly overcrowded and more space is needed. Also, before the library can be put upon an efficient working basis, much work needs to be done in completing sets, binding and cataloging. This cannot be done without the expenditure of more funds for purchasing missing publications, for binding and for the employment of additional clerical help.

Publications

Aside from bulletins, circulars and other publications of the Station, members of the staff prepared technical and popular papers for agricultural journals and magazines. The following list is complete as to the Station publications proper, but incomplete as to papers published elsewhere.

BULLETINS

287 Analyses and Valuations of Commercial Fertilizers and Ground Bone. Analyses of Agricultural Lime.

288 Investigations Relative to the Use of Nitrogenous Plant-Foods, 1898–1912.

289 Cylinder Experiments Relative to the Utilization and Accumulation of Nitrogen.
290 Fertilizer Registrations for 1916.
291 The Influence of the Tannin Content of the Host Plant on Endothia Parasitica and Related Species.
292 The Response of the House-Fly (Musca domestica L.) to Ammonia and Other Substances.
293 Effect of Pruning Peach Trees at Different Heights Previous to Planting in the Orchard.
294 Farm Profits and Factors Influencing Farm Profits on 370 Potato Farms in Monmouth County, N. J.
295 Commercial Feeding Stuffs and Registrations for 1916.
296 The More Important Greenhouse Insects.
297 Analyses of Commercial Fertilizers, Fertilizer Supplies and Home Mixtures.

CIRCULARS

49 Management of the Farm Poultry Flock.
50 Common Diseases of Beans.
51 Diseases of Grains and Forage Crops.
52 Common Diseases of the Pear.
53 Potato Diseases in New Jersey.
54 Improving Acid Soils.
55 Common Diseases of the Grape.
56 The Strawberry Weevil.
57 Asparagus.
58 Suggested Grades for Peaches.
59 The New Jersey Seed Law.
60 Weed Control.
61 The Agricultural Value of Greensand Marl.
62 Digest and Copy of Law regulating the Weighing, Testing and Purchasing of Milk and Cream, being Chapter 31, Laws of 1916.

REPORTS

36 1915 Thirty-sixth Annual Report New Jersey State Agricultural Experiment Station and Twenty-seventh Annual Report New Jersey Agricultural College Experiment Station.

The Experiment Station has also issued during the year the monthly publication, "Hints to Poultrymen," Vol. IV., No. 2 to 12, and Vol. V, No. 1.

EXTENSION BULLETINS PUBLISHED BY THE STATE AGRICULTURAL COLLEGE

Vol. 1, No. 8 Second Annual Report of the Division of Extension for the year ending October 31, 1915.
Vol. 1, No. 9 Announcement of Educational Milk-Scoring Demonstrations.

The Weekly News Letter, Vol. III, Nos. 1 to 52, was published during the year by the Extension Division of the State Agricultural College.

TECHNICAL PAPERS

"Factors Influencing the Protein Content of Soybeans." J. G. Lipman and A. W. Blair, Soil Science, Vol. I, No. 2, February, 1916.

"Yield and Nitrogen Content of Soybeans as Affected by Inoculation." J. G. Lipman and A. W. Blair, Soil Science, Vol. I, No. 6, June, 1916.

"Review of Soil Bacteria and Soil Fertility, by F. Löhnis." J. G. Lipman. Journal of the American Chemical Society, April, 1916.

"Influence of Lime on the Yield and Nitrogen Content of Corn." A. W. Blair and H. C. McLean, Soil Science, Vol. I, No. 5, May, 1916.

"The Actinomyces of the Soil." S. A. Waksman and R. E. Curtis, Soil Science, Vol. I, No. 2, February, 1916.

"Influence of Lime on the Yield and Nitrogen Content of Corn." A. W. Blair and H. C. McLean, Soil Science, Vol. I, No. 5, May, 1916.

"The Oxidation of Sulfur in Soils as a Means of Increasing the Availability of Mineral Phosphates." J. G. Lipman, H. C. McLean and H. C. Lint, Soil Science, Vol. I, No. 6, June, 1916.

"Incubation Studies with Soil Fungi." S. A. Waksman and R. C. Cook, Soil Science, Vol. I, No. 3, March, 1916.

"Bacterial Numbers in Soils at Different Depths and Different Seasons of the Year." S. A. Waksman, Soil Science, Vol. I, No. 4, April, 1916.

"Soil Fungi and Their Activities." S. A. Waksman, Soil Science, Vol. 2, No. 2, August, 1916.

"Protozoa as Affecting Bacterial Activities in Soil." S. A. Waksman, Soil Science, Vol. 2, No. 4, October, 1916.

"Effect of Grinding on the Lime Requirement of Soils." R. C. Cook, Soil Science, Vol. I, No. 1, January, 1916.

"Quantitative Media for the Estimation of Bacteria in Soils." R. C. Cook, Soil Science, Vol. I, No. 2, February, 1916.

"Diastase Activity and Invertase Activity of Bacteria." George P. Koch, Soil Science, Vol. I, No. 2, February, 1916.

"Can Soil be Sterilized Without Radical Alteration?" David A. Coleman, H. Clay Lint and Nicholas Kopeloff, Soil Science, Vol. I, No. 3, March, 1916.

"The Inoculation and Incubation of Soil Fungi." Nicholas Kopeloff, Soil Science, Vol. I, No. 4, April, 1916.

"The Effect of Soil Reaction on Ammonification by Certain Soil Fungi." Nicholas Kopeloff, Soil Science, Vol. I, No. 6, June, 1916.

"Environmental Factors Influencing the Activity of Soil Fungi." David A. Coleman, Soil Science, Vol. 2, No. 1, July, 1916.

"Preliminary Investigations in Comparison of Field with Laboratory Experiments in Soil Biology." George P. Koch, Soil Science, Vol. 2, No. 1, July, 1916.

"Sources of Error in Soil Bacteriological Analysis." H. C. Lint and David A. Coleman, Soil Science, Vol. 2, No. 2, August, 1916.

"Studies on the Activity of Soil Protozoa." George P. Koch, Soil Science, Vol. 2, No. 2, August, 1916.

"Sulphur on Alkali Soils." J. G. Lipman, Soil Science, Vol. 2, No. 3, September, 1916.

"Some Bacteriological Studies on Agar Agar." Carl R. Fellers, Soil Science, Vol. 2, No. 3, September, 1916.

"Factors Affecting the Absorption and Distribution of Ammonia Applied to Soils." R. C. Cook, Soil Science, Vol. 2, No. 4, October, 1916.

"The Influence of Various Salts on the Growth of Soybeans." J. W. Shive, Soil Science, Vol. I, No. 2, February, 1916.

"The Influence of the Tannin Content of the Host Plant on Endothia Parasitica and Related Species." M. T. Cook and G. W. Wilson, Botanical Gazette, November, 1915.

"The Influence of Ether on the Growth of Endothia." M. T. Cook and G. W. Wilson, Botanical Gazette, November, 1915.

"The Pathology of Ornamental Plants." M. T. Cook, Botanical Gazette, November, 1916.

"Two Interesting Diseases of Greenhouse Tomatoes." M. T. Cook and C. A. Schwarze, Phytopathology, August, 1916.

"The Study of Plant Diseases in the High School." M. T. Cook, School Science and Mathematics, Vol. 16, 1916.

"Sulphur-Arsenical Dusts Against the Strawberry Weevil." T. J. Headlee, Jour. of Econ. Ent., Vol. 9, No. 1, 1916.

"The Value of Experimental Study to the Practical Work of Mosquito Control." T. J. Headlee, Proceedings of the Third Annual Meeting of the N. J. Mos. Exter. Ass'n, 1916.

"Fruit Insects of the Year." T. J. Headlee, Proceedings of the N. J. State Hort. Soc., 1915.

"A Chemotropic Response of the House-fly." C. H. Richardson, Science, Vol. 44, No. 1113, 1916.

"Attraction of Diptera to Ammonia." C. H. Richardson, Annals Ent. Soc. of Amer., December, 1916.

"The Influence of Various Concentrations of Sea Water on the Viability of the Salt Marsh Mosquitoes, *Aedes sollicitans* and *Aedes Cantator*." F. E. Chidester and R. S. Patterson, Ent. News, June, 1916.

"Notes on *Leptoypha mutica* Say." H. B. Weiss, Ent. News, July, 1916.

"The Distribution of the Periodical Cicada in New Jersey." H. B. Weiss, Ent. News, October, 1916.

"*Monarthropalpus buxi* in New Jersey." H. B. Weiss, Psyche, October, 1916.

"The Ash Bug, *Neoborus amœnus*." H. B. Weiss, Jour. N. Y. Ent. Soc., December, 1916.

"Additions to Insects of New Jersey, No. 3." H. B. Weiss, Ent. News, January, 1916.

"Additional Records of N. J. Acarina." H. B. Weiss, Ent. News, March, 1916.

"Foreign Insects Recently Established in New Jersey." H. B. Weiss, Jour. Econ. Ent. February, 1916.

"The Coccidæ of New Jersey Greenhouses." H. B. Weiss, Psyche, February, 1916.

"The Insect Fauna of New Jersey Greenhouses, Exclusive of Coccidæ." H. B. Weiss, Jour. N. Y. Ent. Soc., June, 1916.

"Additions to Insects of New Jersey, No. 4." H. B. Weiss, Ent. News, April, 1916. Nineteen notices of various species were also published.

"Distinctive Marks of American and European Foul Brood of Bees." E. G. Carr, American Bee Journal, February, 1916.

POPULAR ARTICLES

"Greatest Need of Eastern Agriculture." J. G. Lipman. Pennsylvania Farmer, December 15, 1915.

"How Often to Inoculate." J. G. Lipman. Country Gentlemen, November 20, 1915.

"Potash in Cotton Seed Meal." J. G. Lipman. The Country Gentlemen, April 8, 1916.

"Soil Fermentation and the Feeding of Crops." J. G. Lipman. Rural New Yorker. 1916.

"Fertilizers for Fruit Orchards." J. G. Lipman. Proceedings Massachusetts State Horticultural Society. 1916.

"The Fertilizer Problem in New Jersey." J. G. Lipman. Annual Report of the New Jersey State Board of Agriculture. 1916.

"Political and Economic Consideration in Mosquito Extermination Work." J. G. Lipman. Proceedings of the New Jersey Mosquito Extermination Association. 1916.

"The Potash Situation and Notes from the West." J. G. Lipman. Proceedings of the New Jersey State Horticultural Society. 1916.

"Picking, Packing and Shipping Peaches." Part I, M. A. Blake, Rural New Yorker, July 15, 1916.

"Picking, Packing and Shipping Peaches." Part II, M. A. Blake, Rural New Yorker, July 22, 1916.

"Picking, Packing and Shipping Peaches." Part III, M. A. Blake, Rural New Yorker, July 29, 1916.

"Picking, Packing and Shipping Peaches." Part IV, M. A. Blake, Rural New Yorker, August 5, 1916.

"Picking, Packing and Shipping Peaches." Part V, M. A. Blake, Rural New Yorker, August 12, 1916.

"Picking, Packing and Shipping Peaches." Part VI, M. A. Blake, Rural New Yorker, August 19, 1916.

"Top-working Peach Trees." Part I, M. A. Blake, Rural New Yorker, March 4, 1916.

"Top-working Peach Trees." Part II, M. A. Blake, Rural New Yorker, March 11, 1916.

"Forty Years of History." M. A. Blake, Proceedings of N. J. State Hort Soc. for 1915.

"Culture of the Strawberry." M. A. Blake, The Field, June, 1916.

"Dynamite and Fruit Trees." A. J. Farley, The Field, November, 1915.

"Planting an Apple Orchard." A. J. Farley, The Field, December, 1915.

"Pointers for Pruning Apple Trees." A. J. Farley, The Field, February, 1916.

"Spraying Peaches." A. J. Farley, Proceedings of State Hort. Soc. of Pennsylvania for 1916.

"Harvesting, Packing and Marketing the Peach." A. J. Farley, Proceedings of State Hort. Soc. of Pennsylvania for 1916.

"Rules and Methods for Judging Apples." A. J. Farley, Peninsula Hort. Sec. Report for 1916.

"The Swine Industry in New Jersey." F. C. Minkler, Bul. 1, N. J. Dept. of Agriculture.
"The A. B. C. of Feeding." F. C. Minkler, The Field, February, 1916.
"Problems in Pork Production." F. C. Minkler, The Berkshire World, March, April and May, 1916.
"Show Ring Publicity." F. C. Minkler, Guernsey Breeders' Journal, September, 1916.
"Limiting Factors in Pork Production." F. C. Minkler, Duroc Jersey Bulletin and the Berkshire World, January, 1916.
"Calculating Feed Values." L. S. Riford, Hoard's Dairyman, December 3, 1915.
"Corn and Alfalfa." L. S. Riford, Hoard's Dairyman, February 25, 1916.
"Suitable Litters for Laying Houses." W. C. Thompson, Everybody's Poultry Magazine, November, 1915.
"The Breeding Pen for the Egg Farmer." W. C. Thompson, Everybody's Poultry Magazine, December, 1915.
"Advertising Poultry Products." W. C. Thompson, Everybody's Poultry Magazine, January, 1916.
"The Incubator Cellar." W. C. Thompson, Everybody's Poultry Magazine, February, 1916.
"Babes in Chickland." W. C. Thompson, Everybody's Poultry Magazine, March, 1916.
"Spring Ranges for Poultry." W. C. Thompson, Everybody's Magazine, April, 1916.
"Fields for Chickens." W. C. Thompson, Everybody's Poultry Magazine, May, 1916.
"Colony Houses for Use on the Summer Range." W. C. Thompson, Everybody's Poultry Magazine, June, 1916.
"The Three S's in Successful Range-chick Growth." W. C. Thompson, Everybody's Poultry Magazine, July, 1916.
"The Man in the Chicken Business." W. C. Thompson, Everybody's Poultry Magazine, August, 1916.
"Why Keep Records this Year?" W. C. Thompson, Everybody's Poultry Magazine, September, 1916.
"Diseases—Prevent them this Winter." W. C. Thompson, Everybody's Poultry Magazine, October, 1916.
"The Poultry Drug Shop." H. R. Lewis, The Country Gentlemen, November, 1915.
"City Chickens." H. R. Lewis, The Country Gentlemen, October, 1915.
"Making a Living from the Poultry Flock." H. R. Lewis, Eugene McGuckin Co., Magazine Edition Sunday Papers, November 24, 1915.
"Evolution and Possibilities of the Day Old Chick Industry." H. R. Lewis, Eugene McGuckin Co., Magazine Edition Sunday Papers, February 19, 1916.
"Securing a Supply of Cheap Eggs in Winter." H. R. Lewis, Eugene McGuckin Co., Magazine Edition Sunday Papers, March 6, 1916.
"Maintaining a Healthy Flock." H. R. Lewis, Everybody's Poultry Magazine, November, 1915.
"Increasing the Quality of Market Eggs." H. R. Lewis, Everybody's Poultry Magazine, December, 1915.
"The February Hatched Pullet." H. R. Lewis, Everybody's Poultry Magazine, January, 1916.
"Producing Quality Chicks." H. R. Lewis, Everybody's Poultry Magazine, February, 1916.
"Operating the Colony Brooder Stove." H. R. Lewis, Everybody's Poultry Magazine, March, 1916.
"Meat, Milk and Bone." H. R. Lewis, Everybody's Poultry Magazine, April, 1916.
"That Summer Range." H. R. Lewis, Everybody's Poultry Magazine, May, 1916.
"Summer Greens on Restricted Range." H. R. Lewis, Everybody's Poultry Magazine, June, 1916.
"Every Inch a Hen." H. R. Lewis, Everybody's Poultry Magazine, July, 1916.
"Playing the Hen Game." H. R. Lewis, Everybody's Poultry Magazine, August, 1916.
"Breeding the Heavy Layers." H. R. Lewis, Everybody's Poultry Magazine, September, 1916.
"Quality Poultry Meat." H. R. Lewis, Everybody's Poultry Magazine, October, 1916.
"The Problem of the Poultry Feeder." H. R. Lewis, The Field, November, 1915.
"The Utility and Fancy in the Poultry Game." H. R. Lewis, The Field, December, 1915.
"The Art and Science of Artificial Hatching." H. R. Lewis, The Field, March, 1916.
"The Mother Hen's Rival." H. R. Lewis, The Field, April, 1916.

"America's Premier Fowl—The Barred Plymouth Rock." H. R. Lewis, The Field, June, 1916.

"Keeping the Poultry Flock Healthy." H. R. Lewis, The Countryside Magazine, November, 1915.

"Owning a Poultry Flock of Your Own." H. R. Lewis, The Countryside Magazine, January, 1916.

"Feeding the Laying Hen." H. R. Lewis, The Countryside Magazine, February, 1916.

"Efficiency in Roaster Production." H. R. Lewis, Journal of American Association of Instructors and Investigators of Poultry Husbandry, March, 1916.

"Meat Scrap in the Laying Ration." H. R. Lewis, Journal of American Association of Instructors and Investigators of Poultry Husbandry, April, 1916.

"Sour Milk for Laying Hens." H. R. Lewis, Journal of American Association of Instructors and Investigators of Poultry Husbandry, June, 1916.

"Cotton Seed Meal in the Poultry Ration." R. F. Irvin, Southern Agriculturist, January 12, 1916.

"Marketing Eggs in the South." R. F. Irvin, Southern Agriculturist, May 3, 1916.

"Relation of Moisture to a Successful Hatch." R. F. Irvin, Everybody's Poultry Magazine, April, 1916.

"Summer Ranges for Chickens." R. F. Irvin, Rural New Yorker, May 20, 1916.

"The Capon—An Outlet for Surplus Cockerels." R. F. Ivin, Everybody's Poultry Magazine, June, 1916.

"The Leghorn Broiler." R. F. Irvin, Country Gentlemen, June 10, 1916.

"Gape Worms in Chickens." R. F. Irvin, Farm and Fireside, June 6, 1916.

"The Capon on the Farm." R. F. Irvin, Pennsylvania Farmer, August, 1916.

"Fall House Cleaning of the Poultry Plant." R. F. Irvin, Pennsylvania Farmer, September 30, 1916.

"Poultry Equipment Which Can Be Made At Home." V. G. Aubry, The Field, March, 1916.

"Fertilizing Sweet Potatoes." R. W. DeBaun, Pennsylvania Farmer, April 15, 1916.

"The Canhouse Tomato Crop." R. W. DeBaun, Pennsylvania Farmer, June 10, 1916.

"How to Prepare Vegetables for Exhibition Purposes." R. W. DeBaun, Pennsylvania Farmer, August 5, 1916.

"Growing Peas and Beans for Canneries." R. W. DeBaun, Pennsylvania Farmer, August 19, 1916.

"Increasing Potato Yields." R. W. DeBaun, Pennsylvania Farmer, October 7, 1916.

"New Methods of Growing Everbearing Strawberries." R. W. DeBaun, Pennsylvania Farmer, October 7, 1916.

"Labor Saving Methods." R. W. DeBaun, Country Gentlemen, July 22, 1916.

"Gathering the Root Crop." R. W. DeBaun, Country Gentlemen, October 29, 1916.

"Series on 'Spinach for Fall and Winter Use.'" R. W. DeBaun, Rural New Yorker, September, 1916.

"Advantages of Garden Peas." R. W. DeBaun, Rural New Yorker, May 6, 1916.

"Late Cauliflower." R. W. DeBaun, Rural New Yorker, May 6, 1916.

"Cantaloupe Growing." R. W. DeBaun, American Agriculturist, April 22, 1916.

"Treatment of Cabbage Seed." R. W. DeBaun, American Agriculturist, April 29, 1916.

"Fall Work with Truck." R. W. DeBaun, American Agriculturist, October 21, 1916.

New Jersey notes are run in every issue of the Market Growers' Journal, by R. W. DeBaun, to increase the interest of the New Jersey vegetable growers in co-operation, extension work and agricultural advancement.

VI

THE STATION STAFF

Resignations—Frank C. Ashbolt, Assistant Herdsman, Dairy Department; Samuel I. Hoddeson, Assistant Chemist; Joseph J. Williams, Microscopist; Henry H. Brehme, Field Assistant, Mosquito Work; Arthur C. Foster, Assistant Seed Analyst; Homer E. Carney, Assistant Seed Analyst; Joseph Gragano, Helper, Floriculture Department; S. A. Waksman,

Research Assistant; William S. Porte, Research Assistant; Charles H. Richardson, Jr., Assistant Entomologist; A. L. Clark, Assistant State Leader of Farm Demonstration; Miss Emily P. Leeds, Assistant Girl's Club Leader.

Transfers—John W. Bartlett, transferred from Horticultural Department to Extension Department; Lawrence G. Gillam, transferred from Horticultural Department to Extension Department.

Appointments—Joseph Hadley, Assistant Herdsman, Dairy Department; Louis J. Kleinfeld, Assistant Chemist; Frank O. Fitts, Assistant Chemist; D. James Kay, Assistant Chemist; Ralph M. Hubbard, Field Assistant; Paul J. Sassi, Field Assistant; Herman J. Levine, Assistant in Vegetable Gardening; David Schmidt, Field Assistant; Franklin O. Church, Research Assistant; Fidel P. Schlatter, Research Assistant; Thurlow C. Nelson, Assistant Biologist, Oyster Work; P. C. Cameron, Laboratory Assistant, Oyster Work; J. Richard Nelson, Laboratory Assistant, Oyster Work; Nevada S. Evans, Assistant Seed Analyst; George Smith, Helper, Floriculture Department; J. R. Neller, Research Assistant; Alvah Peterson, Assistant Entomologist; Lawrence G. Gillam, Specialist in Fruit Growing; A. M. Goodman, County Superintendent of Farm Demonstration for Morris County; Allen G. Waller, Assistant Specialist in Agronomy; Harry C. Haines, Assistant Specialist in Fruit Growing; Emily P. Leeds, Assistant Girls' Club Leader; John B. R. Dickey, Specialist in Soil Fertility and Agronomy; William H. McCallum, State Leader in Boys' Clubs; William H. Hamilton, Assistant County Superintendent of Farm Demonstration for Mercer County; John W. Bartlett, Specialist in Dairy Husbandry; Elwood L. Chase, County Superintendent of Farm Demonstration for Passaic County; John H. Hankinson, State Leader of Farm Demonstration; Miss Fannie F. Cooper, State Leader of Girls' Club Work.

The Station has suffered great loss through the unexpected death of Dr. Julius Nelson, which occurred on February 15, 1916. Dr. Nelson served for many years as Biologist of the Station, and in this capacity carried on important research. The results of his investigations form a distinct addition to our knowledge of oyster propagation and oyster culture. His loss is keenly felt by his associates.

Mr. D. Manley Jobbins, in charge of the greenhouses of the Station since September 1, 1908, died suddenly on November 9, 1916. Mr. Jobbins was an unusually faithful and efficient employe. His loyalty and service were highly prized, and his untimely death is regretted by all who knew him.

REPORT OF THE DEPARTMENT OF CHEMISTRY

Report of the Department of Chemistry

CHARLES S. CATHCART, M.Sc., *Chemist.*
RALPH L. WILLIS, B.Sc., *Assistant Chemist.*
*LOUIS J. KLEINFELD, *Assistant Chemist.*
†FRANK O. FITTS, B.Sc., *Assistant Chemist.*
‡D. JAMES KAY, B.Sc., *Assistant Chemist.*
ARCHIE C. WARK, *Laboratory Assistant.*
W. ANDREW CRAY, *Sampler and Assistant.*
HERBERT P. ROOD, *Sampler and Assistant.*

* Resigned October 31, 1916.
† Appointed April 6, 1916.
‡ Appointed June 19, 1916.

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Report of the Department of Chemistry

Charles S. Cathcart

I

INTRODUCTORY

The activities of the Department of Chemistry for the fiscal year ending October 31, 1916, have been along the same general lines as those given in previous reports, and were largely confined to the inspection work as required by the laws regulating the sale of fertilizers, agricultural lime, feeding stuffs and insecticides. The work required by the inspections has been constantly increasing from year to year and, in order to complete the work in a given time, it is necessary to follow closely a prepared schedule. Under the conditions it is, therefore, impracticable to undertake any additional work that would require any considerable time to finish. In addition to the inspection work, occasional analyses have been made for other departments of the Station and for county demonstrators.

During the year 2,278 samples were examined and duly reported. These examinations required about 19,000 separate determinations.

II

INSPECTION OF COMMERCIAL FERTILIZERS

The inspection of the fertilizers sold in this State was made in accordance with the law entitled "An Act Concerning Fertilizers," which was approved March 27, 1912. The principal objects of this law are: (1) the protection of the purchaser and (2) the protection of the honest manufacturer. This protection is secured by the various requirements of the law relating to the registration and branding, the sampling and analyses of materials sold, the publication of the results of the inspections and, also, defining the penalty for the violation of any of the requirements.

Registrations

Annual registrations are required to be submitted on November 1, but a manufacturer is permitted to register a new brand at any time during the year, provided that this requirement is complied with before the material is actually placed on the market. Judging from information received during the past inspections, it is quite evident that some of the manufacturers do not at all times consider the question of registration to be very important, and as a result it is overlooked until their attention has been called to the omission, or it is entrusted to someone who does not make the record which will exactly correspond to the statements that are attached to the materials as sold. In order that a registration may cover a given brand it is absolutely necessary that the statements as registered, including the brand names as well as the guarantees, must correspond with the statements attached to the materials. If the two statements do not agree in every particular, it must be considered that the brand in question has not been registered.

The whole question of registration, since it is one of the requirements of the law, is important, and each manufacturer or person responsible for a fertilizer on our markets should make arrangements so that the registrations may not only be made at the time specified, but, also, when they are made the information given should be accurate.

During the year, 131 firms or persons registered 1,493 brands, 111 of which were not registered, however, until the brands had been located by our inspectors. The unregistered brands that were collected represented the products of 42 manufacturers and consisted of 115 different brands. The following manufacturers failed to make the necessary registrations for the remaining four brands: E. M. Carman, Englewood, N. J.; L. H. Chambers, Mt. Holly, N. J.; Vaughan Seed Store, Chicago, Ill.; W. Wilde, Vineland, N. J.

The registrations received up to January 18, 1916, were published in Bulletin 290, and the remaining registrations were published in Bulletin 303.

Inasmuch as the law prescribes the form of guarantee to be attached to the materials sold, it is necessary, before a brand is registered, to insist that the application blank should show all of the guarantees required, and it is expected to find the registered guarantees attached to the materials. A few applications have been received which did not give all of the guarantees required, but the corrected applications were complete and, with but a few exceptions, the full information was attached to the

materials. The condition has been taken up with the parties concerned and there should be no reason for their future shipments not being correctly guaranteed.

It is admitted that under normal conditions the manufacturers have many problems to solve in order to comply with the laws of the various states, and during the past year they undoubtedly have experienced additional difficulties which were caused by the scarcity of some of the materials used in preparing the brands. On account of one of the requirements of the law of this State, when a manufacturer could not supply the full guarantee previously given for any brand, it was necessary to adopt a new name for the mixture. The scarcity of the potash compounds, therefore, compelled the manufacturers to prepare many new mixtures, and, under the conditions, one would have expected to find many of the standard brands with the guarantees lowered. This condition, however, did not exist since all of the manufacturers, with but a single exception, branded their materials in accordance with the requirements, and the attitude which they have taken reflects great credit upon their business methods.

The one case of incorrect branding which was referred to could have been avoided if the company responsible for the condition, Taylor Provision Co., Trenton, N. J., had applied for registration at the proper time. This was not done, however, and the question was not taken up by them until after the materials had been sold and sampled by our inspector. A full explanation was given, but since the entire output had been sold, an adequate adjustment was difficult. It was finally agreed that each purchaser should be made to understand clearly that an error had been made in the branding, and that in the future the registrations would be made at the proper time.

Reports on Tonnage

In accordance with the law and also with the certified statements made at the time of registering the brands to be offered for sale, reports on the tonnage sold are required to be rendered on April 1 and November 1 of each year. We have had no reason to question any of the reports that have been rendered, with the exception of the April report for this year, which was submitted by the Standard Guano Co., Baltimore, Md. This report was very much smaller than their known sales and it is supposed that an error was made when the report was prepared, but it was impossible to secure from the company any information regarding the discrepancy. After waiting a suitable time the party purchasing the materials from this company paid the required inspection fee.

The following is a summary of the reports received during the past four years:

Year	April Reports: Mixed Fertilizers Tons	April Reports: Fertilizer Materials Tons	November Reports: Mixed Fertilizers Tons	November Reports: Fertilizer Materials Tons	Total for the Year Tons
1913,	87,446.91	10,303.17	51,706.28	7,204.79	156,661.15
1914,	78,768.27	8,735.62	59,223.26	8,686.99	155,414.14
1915,	87,052.13	7,276.45	53,288.11	5,459.28	153,075.97
1916,	61,368.88	9,032.68	52,328.81	7,069.70	129,800.07

Wholesale Prices of the Essential Elements of Plant Food for 1915

The wholesale prices of the unmixed or raw materials used in preparing the mixed fertilizers are quoted weekly in the trade journal, "The Oil, Paint and Drug Reporter." In order to express the figures given as prices per pound of actual plant-food which is the form adopted by the experiment stations of this country, the quotations have been recalculated and tabulated for the entire year. On account of the fact that the report of the Station is made on October 31st of each year, the prices that have been tabulated are for the year 1915.

The prices that were quoted for the potash salts were given as "nominal" and are not included in the tabulation.

Table I

Wholesale Cost, Per Pound, in New York

MONTHS, 1915	Of Nitrogen in Form of— Nitrate of Soda. Min.	Of Nitrogen in Form of— Sulphate of Ammonia. Min.	Of Nitrogen in Form of— Dried Blood. Min.	Of Phosphoric Acid in Form of— Acid Phosphate. Min.	Of Phosphoric Acid in Form of— Acid Phosphate. Max.
	Cts.	Cts.	Cts.	Cts.	Cts.
January,	12.13	12.80	17.91	2.25	2.50
February,	13.01	14.39	16.78	2.25	2.50
March,	13.88	15.41	17.00	2.25	2.50
April,	14.56	15.12	16.39	2.25	2.50
May,	14.65	15.61	15.97	2.25	2.50
June,	14.70	15.73	15.25	2.25	2.50
July,	15.08	16.61	16.63	2.25	2.50
August,	15.38	17.12	16.39	2.25	2.50
September,	15.56	16.46	16.32	2.38	2.63
October,	17.80	16.46	16.39	2.75	3.00
November,	18.51	17.41	20.65	3.75	4.00
December,	20.74	19.22	20.65	4.00	4.25
Average, 1915,	15.47	16.03	17.11	2.70	
Average, 1914,	13.39	13.14	19.66	2.88	
Average, 1913,	15.71	15.35	17.48	[illegible]	

Trade Values for 1916

It has been the practice to prepare each year a schedule of trade values which were determined by the use of the wholesale quotations published in the trade paper, and the retail quotations which had been received by the consumers. A tabulation of the various quotations was prepared this year and the great fluctuation in the prices noted. Several of the larger manufacturers were then requested to give us confidentially the prices which they would ask for their materials. The result of a careful study of the different quotations was that if a schedule of trade values were made by the method in use during the past years, the calculated valuations of mixed goods would exceed the prices asked by the manufacturers. It is evident that such valuations would not give the information desired and, consequently, under the conditions it would not be fair to either manufacturer or consumer to use such a schedule. Although this was the conclusion from the information at hand, a final decision was deferred until additional information had been obtained.

In the early part of March the annual conference of the directors and chemists of the experiment stations of the New England States and New Jersey was held. The question of valuations was very thoroughly discussed and it was the unanimous opinion of those present that on account of the great fluctuations in the prices of the various materials used, no schedule could be prepared which would fairly represent the charges to be made during the season.

On account of this condition no schedule of trade values has been prepared for this year, and no valuations have been computed either for fertilizer materials or for mixed fertilizers.

Inspection for 1916

The inspection for the present year was made by two inspectors who have been engaged in this particular kind of work for several years. Every county in the State was visited, and a total of 1,640 samples was received at the Station, all but a small percentage of which being collected by the official inspectors. The samples received represented the stock of 561 dealers and consumers who were located in 230 cities or towns.

The detailed results of the inspection, with the exception of the analyses of the unofficial samples of mixed goods which were reported directly to those submitting the samples, were published in Bulletins 297 and 303.

The samples examined consisted of the following:

565	Samples of Commercial Fertilizers.	
27	" " " "	(Duplicates).
45	" " " "	(Unofficial).
13	" " Home Mixtures.	
208	" " Fertilizer Materials.	
43	" " Ground Bone.	
117	" " Sundry Materials.	
1018	" Total.	

The analyses of these samples required about 11,500 separate determinations.

Guaranteed and Actual Composition

All of the samples, with one exception, were accompanied by guarantees at the time of shipment, although all of the guarantees were not stated in the form required by the fertilizer law. The total number of brands of mixed fertilizers examined was 565, and of this number 289 did not carry any guarantee for potash.

The average analysis of the 276 brands guaranteed to contain nitrogen, phosphoric acid and potash and the average guarantees are as follows:

	Average Found		Average Guaranteed
	%	%	%
Nitrogen, as Nitrates,	0.32	....	....
" " Ammonia Salts,	0.83	....	....
" " Water-Soluble Organic,	0.42	....	....
" " Water-Insoluble Organic,	0.82	....	....
" Total,	....	2.39	2.48
Phosphoric Acid, Total,	10.67	....	....
" " Insoluble,	1.69	....	....
" " Available,	....	8.98	8.37
Potash,	....	1.39	1.40

The average analysis of the 289 brands guaranteed to contain nitrogen and phosphoric acid, and the average guarantees are as follows:

	Average Found		Average Guaranteed
	%	%	%
Nitrogen as Nitrates,	0.45	....	....
" " Ammonia Salts,	1.00	....	....
" " Water-Soluble Organic,	0.51	....	....
" " Water-Insoluble Organic,	1.15	....	....
" Total,	....	3.11	3.18
Phosphoric Acid, Total,	11.25	....	....
" " Insoluble,	2.01	....	....
" " Available,	....	9.24	8.94

The results as shown by the above averages would indicate that the brands taken as a whole substantially satisfied the guar-

antees as given; but, if the individual analyses as published in the bulletins are examined, it will be noted that in some instances the guarantees were not delivered, while in other brands the guarantees were exceeded. A detailed study of the analyses will show that 122 brands satisfied every guarantee given, and in addition to this number 233 brands substantially satisfied the claims of the manufacturers. The remaining 209 brands or about 37 per cent were deficient, and this is the largest percentage of deficient brands that has been reported since 1912. Of the deficient brands 182 were deficient in one element, 26 in two elements and one in all three of the guaranteed elements.

In the brands examined there were 1,406 deficiencies possible, and of this number 237 or 16.9 per cent were found. This is the largest percentage of deficiencies found since 1908. Various causes have been suggested by different manufacturers for this condition, but no statement has been given that would indicate the purchaser was in any way responsible. The charges that were made for all of the shipments were undoubtedly based upon the cost of mixtures that should contain the full amount of plant-food guaranteed and, consequently, those who received brands that were deficient paid an excessive price for their fertilizers. In some cases the manufacturers have given a rebate sufficient to cover the deficiency, but it is safe to say that a large sum of money has been paid by the purchasers for which no value has been received.

Since it is not the duty of the State chemist to enforce the law, it is expected that the purchasers will assist in protecting their own interests by insisting that they should receive an equivalent for their money. Every official sample that is examined is reported to the manufacturer responsible for the material, and, also, to the purchaser of the stock examined. If the purchaser receives a report that is marked "deficient," the question of the value of the material should be taken up with the manufacturer, and it is quite probable that an adjustment will be made. If, however, no satisfactory adjustment is made and the conditions warrant it, the case should be reported to the prosecutor of the county in which the violation occurred, since Section 7 of the law states that if a corporation, firm or person has sold fertilizers found by analysis, made by the State chemist, not to contain substantially the guaranteed percentage of any one of the ingredients in the guaranteed analysis, such corporation, firm or person is guilty of a misdemeanor.

There were 139 deficiencies in the total nitrogen content, and this is the largest number of deficiencies of this element that has

been reported since the inspection work started. This is a serious condition and should be met by prompt and effective measures.

In addition to securing the full amount of nitrogen guaranteed, it is also important to know something of the character of the nitrogen delivered. The law requires the guarantee of total nitrogen to be stated but, as far as the guarantee goes, it may be derived wholly or in part from materials such as nitrate of soda, sulphate of ammonia, cyanamid, dried blood, fish, tankage, bone, garbage tankage, leather, peat, etc. Nitrogen in the form of nitrates was found in 201 brands, while 456 brands contained ammonia salts and 152 brands contained both of these available forms. All of the brands, with one exception, contained organic nitrogen, the value of which depends upon its source. The activity of the organic nitrogen was determined in the samples examined, and in about 16 per cent of the brands the insoluble organic nitrogen was derived from low-grade materials.

There were 81 deficiencies in phosphoric acid and 17 deficiencies in potash.

Summary of the Results of the Inspection

The following tabulation gives the names and addresses of the manufacturers of mixed fertilizers whose brands have been examined this year, as well as a summary of the results obtained. In tabulating these results, a deficiency of 0.20 per cent or less in nitrogen and 0.30 per cent or less in phosphoric acid or potash has been disregarded.

III

INSPECTION OF AGRICULTURAL LIME

The inspection of the products sold as agricultural lime was made in accordance with the law entitled "An Act to Regulate the Sale of Agricultural Lime." The essential features of this law, briefly stated, are:

1. Registration of the brands and the guarantees that will be attached to the materials as sold. 2. The constituents that must be guaranteed. 3. The name and address of the party responsible for the material. 4. The official inspection of the materials offered for sale.

Table II

Summary of Results Obtained with Mixed Fertilizers Examined During 1916

MANUFACTURER	ADDRESS*	Number of Brands Received.	Number of Samples Examined.	Number of Samples Satisfied Guarantees.	Number of Samples Substantially Equal to Guarantees.*	Number of Samples Deficient In— Nitrogen.	Phosphoric Acid.	Potash.	One Element.	Two Elements.	Three Elements.
Acme Guano Co.,	Baltimore, Md.,	7	7		3	3	1		4		
American Agricultural Chemical Co.,	New York City,	70	73	9	41	21		3	22	1	
American Fertilizing Co.,	Baltimore, Md.,	2	2		1		1		1		
Armour Fertilizer Works,	Baltimore, Md., and Chrome, N. J.,	22	23	2	7	10	7	2	9	5	
Atlantic Fertilizer Works,	Baltimore, Md.,	2	2			2			2		
James A. Baird & Son,	Marlboro, N. J.,	3	3	1		1	1		2		
Baugh & Sons Co.,	Philadelphia, Pa.,	23	23	5	14	4			4		
Bennett & Bennett,	Prospect Plains, N. J.,	2	2		1	1			1		
The Berg Co.,	Philadelphia, Pa.,	3	3	1		1	1		2		
Berger Bros.,	Easton, Pa.,	1	1		1						
Bowker Fertilizer Co.,	New York City,	13	14	2	9	3			3		
Burlington County Produce Sales Co.,	Mt. Holly, N. J.,	5	5	1	1	1	2		3		
Burlington Supply Co.,	Burlington, N. J.,	3	3	1		2			2		
E. M. Carman,	Englewood, N. J.,	† 1	1								
Chamberlain & Barclay,	Cranbury, N. J.,	1	1			1			1		
Coe-Mortimer Co.,	New York City,	11	13	4	4	5			5		
J. S. Collins & Son, Inc.,	Moorestown, N. J.,	3	3	1	1	1			1		
Consumers Chemical Corporation,	New York City,	6	6	2	2	2			2		
J. G. Downward Co.,	Coatesville, Pa.,	3	3	1	2						
J. Dugan,	Moorestown, N. J.,	2	2		1		1		1		
Farmers Co-operative Association,	Trenton, N. J.,	4	4		2	2			2		
M. Feinstein,	Bridgeton, N. J.,	2	2		1			1	1		
Fogg & Hires Co.,	Salem, N. J.,	1	1				1		1		
Godfrey Co-operative Fertilizer and Chemical Co.,	Newark, N. J.,	13	13	1	5	5	3		6	1	
James C. Griscom,	Woodbury, N. J.,	2	2	1	1						
Thomas Y. Hackett,	Daretown, N. J.,	1	1	1							

Table II

Summary of Results Obtained with Mixed Fertilizers Examined During 1916—Continued

MANUFACTURER	ADDRESS	Number of Brands Received.	Number of Samples Examined.	Number of Samples Satisfied Guarantees.	Number of Samples Substantially Equal to Guarantees.*	Number of Samples Deficient In—					
						Nitrogen.	Phosphoric Acid.	Potash.	One Element.	Two Elements.	Three Elements.
Hendrickson & Dilatush,	Robbinsville, N. J.,	6	6	3	3	......	......	......	......	......	......
S. M. Hess & Bro., Inc.,	Philadelphia, Pa.,	11	11	3	7	1	......	......	1	......	......
Heritage & Bro.,	Mullica Hill, N. J.,	4	4	1	3	......	......	......	......	......	......
Thomas Hill,	Flemington, N. J.,	1	1	......	1	......	......	......	......	......	......
P. Hoffman & Bro.,	Raubsville, Pa.,	2	2	......	......	......	1	2	1	1	......
Hubbard Fertilizer Co.,	Baltimore, Md.,	3	3	1	1	1	......	......	1	......	......
Hudson Carbon Co.,	Ballston Spa, N. Y.,	3	3	3	......	......	......	......	......	......	......
H. H. Hutchinson, Jr.,	Robbinsville, N. J.,	2	2	......	2	......	......	......	......	......	......
International Seed Co.,	Rochester, N. Y.,	5	5	2	3	......	......	......	......	......	......
H. B. Kemp,	Long Branch, N. J.,	3	3	......	2	1	......	......	1	......	......
Keystone Bone Fertilizer Co.,	Philadelphia, Pa.,	8	8	......	3	2	3	2	4	......	1
William Lancaster,	Philadelphia, Pa.,	3	3	1	1	1	1	......	......	1	......
C. A. Lippincott & Bro.,	Moorestown, N. J.,	1	1	......	......	1	......	......	1	......	......
Listers Agricultural Chemical Co.,	Newark, N. J.,	22	23	8	8	1	6	......	7	......	......
Locke & Black,	Swedesboro, N. J.,	4	5	1	3	1	......	......	1	......	......
Mapes F. and P. Guano Co.,	New York City,	7	7	1	2	......	4	......	4	......	......
Martin Fertilizer Co.,	Philadelphia, Pa.,	7	7	4	......	1	2	......	3	......	......
Middlesex Fertilizer Co.,	Plainfield, N. J.,	3	3	1	2	......	......	......	......	......	......
Mitchel Fertilizer Co.,	Tremley, N. J.,	2	2	2	......	......	......	......	......	......	......
Monmouth County Farmers' Exchange,	Freehold, N. J.,	4	4	2	2	......	......	......	......	......	......
Joseph R. Moore,	Swedesboro, N. J.,	7	7	1	5	1	......	......	1	......	......
Nassau Fertilizer Co.,	New York City,	6	6	3	3	......	......	......	......	......	......
Albert Nelson,	Allentown, N. J.,	6	6	3	2	......	1	......	1	......	......
J. F. Noll & Co.,	Newark, N. J.,	2	2	......	1	......	1	......	1	......	......
Patapsco Guano Co.,	Baltimore, Md.,	5	5	1	2	2	......	......	2	......	......
Philadelphia Guano Works,	Philadelphia, Pa.,	6	6	3	3	......	......	......	......	......	......
Rasin Monumental Co.,	Baltimore, Md.,	9	9	4	2	2	1	......	3	......	......
Reading Bone Fertilizer Co.,	Reading, Pa.,	4	4	......	1	2	2	......	2	1	......

Table II

Summary of Results Obtained with Mixed Fertilizers Examined During 1916—Continued

MANUFACTURER	ADDRESS*	Number of Brands Received.	Number of Samples Examined.	Number of Samples Satisfied Guarantees.	Number of Samples Substantially Equal to Guarantees.*	Number of Samples Deficient In— Nitrogen.	Phosphoric Acid.	Potash.	One Element.	Two Elements.	Three Elements.
Robert A. Reichard,	Allentown, Pa.,	1	1	......	1	......	......	......	......	......	......
Ellwood Roberts Co.,	Philadelphia, Pa.,	3	3	1	1	1	......	......	1	......	......
F. S. Royster Guano Co.,	Baltimore, Md.,	13	15	2	5	6	4	......	6	2	......
Schanck, Hutchinson & Field,	Hightstown, N. J.,	5	5	3	1	1	......	......	1	......	......
Scott Fertilizer Co.,	Elkton, Md.,	7	7	1	1	2	4	......	4	1	......
Sea Board Utilization Co.,	Long Branch, N. J.,	1	1	1	......	......	......	......	......	......	......
M. L. Shoemaker & Co., Ltd.,	Philadelphia, Pa.,	2	2	1	1	......	......	......	......	......	......
Harry L. Sickel,	*Woodbury, N. J.,*	8	8	4	4	......	......	......	......	......	......
South Jersey Farmers' Exchange,	Woodstown, N. J.,	19	26	2	11	9	6	1	10	3	......
Standard Guano Co.,	Baltimore, Md.,	10	10	2	5	2	1	1	2	1	......
H. Stanley,	Westville, N. J.,	1	1	......	1	......	......	......	......	......	......
Swift & Co.,	Baltimore, Md.,	13	13	......	1	7	6	......	11	1	......
Swift & Co.,	Kearny, N. J.,	29	20	7	6	10	12	......	10	6	......
Taylor Bros.,	Camden, N. J.,	2	2	......	1	......	......	1	1	......	......
Taylor Provision Co.,	Trenton, N. J.,	2	2	1	1	......	......	......	......	......	......
I. P. Thomas & Son Co.,	Philadelphia, Pa.,	13	13	5	3	4	1	1	4	1	......
Trenton Bone Fertilizer Co.,	Trenton, N. J.,	9	9	3	4	2	......	......	2	......	......
F. W. Tunnell & Co., Inc.,	Philadelphia, Pa.,	27	34	6	6	11	9	3	21	1	......
J. E. Tygert Co.,	Philadelphia, Pa.,	9	9	1	7	1	......	......	1	......	......
Virginia-Carolina Chemical Co.,	New York City,	12	12	1	5	5	2	......	5	1	......
A. J. Vreeland,	Matawan, N. J.,	1	1	......	1	......	......	......	......	......	......
J. Wenderoth & Sons,	Camden, N. J.,	4	4	3	1	......	......	......	......	......	......
West Jersey Marl and Trans. Co.,	Woodbury, N. J.,	13	13	1	9	3	......	......	3	......	......
W. E. Whann Co.,	Philadelphia, Pa.,	3	3	......	2	1	1	......	......	1	......
William Wilde,	Vineland, N. J.,	2	2	......	1	1	......	......	1	......	......
Abbott Worthley Co.,	Marlboro, N. J.,	3	4	......	3	......	1	......	1	......	......
J. R. Wyckoff,	Princeton Junction, N. J.,	1	2	......	......	2	......	......	2	......	......

* Not over 0.2% low in nitrogen, 0.3% low in phosphoric acid or potash.

During the past year 43 manufacturers registered 87 different brands of agricultural lime. The names and addresses of those who have registered their products are:

Acme Stone and Pulverizing Co., Lebanon, Pa.; American Agricultural Chemical Co., New York City; J. E. Baker Co., York, Pa.; S. W. Barrick & Sons, Woodsboro, Md.; Beam & Co., Philadelphia, Pa.; Blair Limestone Co., Martinsburg, W. Va.; Carbo Agricultural Lime Co., Wilmington, Del.; The Charite Co., Inc., Andover, N. J.; F. E. Conley Stone Co., Utica, N. Y.; Judson Conover, Matawan, N. J.; G. & W. H. Corson, Plymouth Meeting, Pa; Edison Pulverized Limestone Co., New Village, N. J.; J. Philip Exton, Clinton, N. J.; The Fountain Rock Lime Co., Woodsboro, Md.; Godfrey Co-op. Fertilizer and Chemical Co., Newark, N. J.; M. J. Grove Lime Co., Lime Kiln, Md.; James Heritage & Son, Vineland, N. J.; Winfield S. Hoffman, Middle Valley, N. J.; International Agricultural Corporation, Caledonia, N. Y.; Keasbey & Mattison Co., Ambler, Pa.; J. B. King & Co., New York City; Knickerbocker Lime Co., Philadelphia, Pa.; John Kreutz & Sons, Inc., Philadelphia, Pa.; E. J. Lavino & Co., Philadelphia, Pa.; LeGore Combination Lime Co., LeGore, Md.; Weller C. Leigh, Lebanon, N. J.; Merion Lime and Stone Co., Norristown, Pa.; M. C. Mulligan & Son, Clinton, N. J.; E. J. Neighbour, German Valley, N. J.; Palmer Lime and Cement Co., New York City; Lowell M. Palmer, York, Pa.; Philadelphia Lime Co., Inc., Philadelphia, Pa.; Security Cement and Lime Co., Hagerstown, Md.; The Standard Lime and Stone Co., Baltimore, Md.; The Standard Lime and Stone Co., Buckeystown, Md.; Steacy & Wilton Co., Wrightsville, Pa.; Thomasville Stone and Lime Co., Thomasville, Pa.; Tidewater Portland Cement Co., Baltimore, Md.; Todd & Cordes, Peapack, N. J.; Twining & Large, Yardley, Pa.; Vanderhoof Lime Co., Hamburg, N. J.; Charles Warner Co., Wilmington, Del.; Whitemarsh Lime Works, Philadelphia, Pa.

INSPECTION.—Thirty-five samples of the various brands of lime were examined, and the results are given in detail in Bulletin 303.

IV

INSPECTION OF COMMERCIAL FEEDING STUFFS

The detailed report of the annual inspection of commercial feeding stuffs was published in Bulletin 295.

The Experiment Station is endeavoring to look after the interests of the consumers of feeding stuffs as well as the honest manufacturers of these materials, but in order to obtain the best results it is necessary that all dealers and consumers should coöperate. It is impossible to have an inspector present when every shipment is received and, consequently, the dealers and consumers should be familiar with the main requirements of the law. If materials are received which do not comply with the requirements, they should not be accepted and the state chemist should be informed regarding the shipment.

The full text of the law has been published several times and it does not seem necessary to repeat it at this time. The requirements that should be remembered, however, may be briefly stated as follows:

1. The material must be registered by the actual shipper (manufacturer or jobber). 2. The brand name, the guarantees for protein, fat and fiber, and (in mixed feeds) the specific name of each ingredient used in its manufacture must be stated. 3. The name and address of the actual shipper must be attached.

By insisting upon the above requirements the purchaser will not only be coöperating with the Experiment Station in the enforcement of the law, but may save himself some inconvenience should one of our inspectors find a feed that is not properly branded, since it will be necessary to have the matter attended to before the material can be sold.

The law under which this inspection was made is effective only in New Jersey, and the person selling cattle feeds in the State is the one responsible for fulfilling the requirements of the law. Many manufacturers assume these responsibilities in order to protect their various customers, as they realize the advantages to be gained by so doing.

During the past year the writer has received an appointment from the Federal Government as Commissioned State Official and is authorized to take samples of cattle feeds which enter into inter-state commerce. Should deficient or adulterated feeds be located during our regular inspection, the information can be used for starting proceedings in the proper courts of the United States against the shipper. The advantage of the appointment is that the responsibility for the inter-state shipments can be placed upon the shipper instead of upon the local dealer.

REGISTRATIONS.—During the past year 518 manufacturers registered 2,582 brands of feeding stuffs which they intended to offer for sale in this State. Our inspectors found 118 brands that were being offered for sale before the required registrations had been made, and the dealers holding these brands were notified not to dispose of the same until the requirements of the law had been complied with. Registrations were received later for 91 of these brands. The number of unregistered brands found last year was larger than reported above, and it is therefore quite evident that more attention is being given to this requirement.

From the reports rendered by the inspectors, it is noted that there are some manufacturers who do not state in the information

attached to their products exactly the information which was registered. As it is absolutely necessary to have the two statements exactly the same—and these include the brand names, the guarantees for protein, fat and fiber, and the specific names of the ingredients used in mixed feeds—great care should be used to accomplish this end. A brand that is registered with certain guarantees does not cover a material which carries a different guarantee, although the same brand name may be used.

The feeding-stuffs law as enacted four years ago contained requirements that were new to the local dealers and consumers, and in order that everyone could become familiar with the requirements regarding the method of branding, some allowances have been made in the past. Inasmuch as everyone has been given sufficient opportunity to learn the method of procedure, it will be necessary in the future to have all deficient branding corrected before the sale of the material is approved.

Tonnage of Feeding Stuffs Sold

The law requires reports to be filed on July 1 and January 1 of each year showing the tonnage of feeding stuffs sold during the preceding six months. The following is a summary of the reports received covering the sales made during 1913, 1914 and 1915:

Year	July Reports	January Reports	Total for the Year
1913, ...	93,664.17	102,560.00	196,224.17
1914.	88,192.50	114,508.73	202,701.23
1915, ...	103,626.91	124,563.34	228,190.25

INSPECTION.—During the inspection 1,467 samples were received, and of this number 49 were forwarded by individuals and the others were collected by the regular inspectors who visited every county in the State. The samples were secured in 166 cities and towns, and represented the stock of 333 dealers and consumers.

EXAMINATION.—Each brand collected was examined microscopically, in order to determine the ingredients present. They were also examined by use of the official methods as adopted by the Association of Official Agricultural Chemists, in order to determine the content of protein, fat and fiber.

Results of the Inspection

The laboratory work of the inspection consisted of the examination of 1,151 samples, 49 of which being unofficial samples

were reported directly to the party requesting the examination. Of the 1,102 official samples examined, 294, or 26.6 per cent, did not satisfy all of the guarantees given. The deficiencies due to the ingredients found are not included in the above figures. Last year the percentage of deficient samples was 17.7, which shows that there was a falling off in the grades of feeds furnished. It would be difficult to state the cause of this backward movement, but the fact remains that an unusually large number of shipments were deficient and, with two or three exceptions, were paid for at prices that were fixed for materials containing the guaranteed amounts of the nutrients.

The total number of deficiencies noted was protein 103, fat 103 and fiber 154. There were 233 samples deficient in one nutrient, 53 deficient in two nutrients and 7 deficient in the three nutrients. The percentage of samples that was found deficient in protein and fat is about the same as reported last year. There was a very large increase in the percentage of fiber deficiencies, and this increase is sufficient to account for the poorer showing as found during this inspection.

Table III gives a summary of the inspection. It will be noted that the average composition and the average selling prices of Calf Meals, Feed Mixtures and Poultry Foods are not given. These averages were not calculated on account of the variable character of the different brands reported under the respective headings. In preparing this tabulation the Protein as found is considered to satisfy its guarantee if it is not more than one per cent below it. An allowance of 0.5 per cent also is made for Fat and for Fiber determinations.

V

INSPECTION OF INSECTICIDES

The law of New Jersey entitled "An Act to Regulate the Sale of Insecticides," requires the various materials that are sold for "preventing, destroying, repelling or mitigating any insects which may infest vegetation" to be registered at the office of the State chemist. This registration consists of a statement of the name and address of the manufacturer or the party responsible for its sale; the brand name of the material and the guarantee that will be attached to the material when offered for sale. The law also requires an annual inspection of these materials found in our markets and the publication of the results as obtained.

In accordance with these requirements the results of the inspection were published in Bulletin 301.

Table III

Summary of Results of Inspection of Feeding Stuffs

FEEDING STUFF	Number of Guaranteed Samples Examined	AVERAGE COMPOSITION: Moisture	AVERAGE COMPOSITION: Protein	AVERAGE COMPOSITION: Fat	AVERAGE COMPOSITION: Fiber	Average Retail Selling Price Per Ton	Number of Samples Satisfied Guarantees	NUMBER OF SAMPLES DEFICIENT IN—: Protein	Fat	Fiber.	One Nutrient	Two Nutrients	Three Nutrients
		%	%	%	%								
Alfalfa Meal,	10	7.53	14.19	1.07	28.45	$31.78	6	2		2	4		
Blood Meal,	1	9.29	83.94	0.26		*4.00		1			1		
Brewers' Dried Grains,	17	6.48	26.62	6.54	13.83	20.25	9	3	1	5	7	1	
Buckwheat Feed,	4	13.54	21.33	5.80	2.74	25.93	2	2			2		
Buckwheat Middlings,	21	12.30	29.26	7.86	3.88	20.00	15	3	2	3	4	2	
Buckwheat Offal,	10	11.11	17.24	4.61	18.83	23.60	4	4	3	6	2	1	3
Calf Meals,	7						4		2	1	3		
Cocoanut Meal,	2	7.75	21.60	10.46	8.83	28.00	2						
Copra Cake Meal,	1	8.19	21.75	7.54	10.25	39.00		1	1			1	
Cottonseed Meal,	21	7.92	39.06	7.23	9.37	37.75	16	5	1	2	3	1	1
Corn Bran,	5	7.83	10.49	7.37	6.98	27.40	5						
Corn Feed Meal,	18	11.76	8.86	4.17	1.84	33.22	12	1	2	4	5	1	
Corn Gluten Feed,	17	8.59	26.06	2.69	6.46	30.11	15		2		2		
Corn Gluten Meal,	1	7.87	40.63	1.01	1.43		1						
Corn and Cob Meal,	28	11.91	7.21	3.32	5.92	21.15	12	3	11	8	11	4	1
Corn and Oats,	36	11.23	9.55	4.30	3.58	33.24	26	2	3	6	9	1	
Distillers' Grains—Corn,	2	6.32	33.28	10.37	10.26	34.50	1		1		1		
Distillers' Grains—Mixed,	3	9.05	19.65	0.57	16.12	26.25	2		1		1		
Dried Beet Pulp,	3	8.74	8.42	0.71	19.06	27.25	3						
Feeding Flour,	12	9.45	16.42	4.80	2.91	37.73	7	3	2	1	4	1	
Feed Mixtures,	292						214	22	25	49	60	18	
Fish Scrap,	1	8.47	49.81	1.99		*3.25	1						
Hominy Meal and Feed,	13	8.67	11.27	7.72	3.06	31.73	13						
Linseed Oil Meal,	12	8.91	32.16	5.64	8.20	43.38	8	4			4		
Malt Sprouts,	6	7.17	26.33	1.16	12.76	28.17	2	2	3	1	3		1
Meat Scrap,	23	6.65	49.09	14.15		57.30	12	10	2		10	1	
Oat Hulls,	1	5.64	3.06	1.13	30.45					1	1		

Table III

Summary of Results of Inspection of Feeding Stuffs—Continued

FEEDING STUFF	Number of Guaranteed Samples Examined	AVERAGE COMPOSITION				Average Retail Selling Price Per Ton	Number of Samples Satisfied Guarantees	NUMBER OF SAMPLES DEFICIENT IN—					
		Moisture	Protein	Fat	Fiber			Protein	Fat	Fiber	One Nutrient	Two Nutrients	Three Nutrients
		%	%	%	%								
Peanut Oil Meal,	4	7.44	38.14	10.26	6.78	34.50	2	1	.....	1	2	.....	.....
Poultry Bone,	2	7.41	24.97	1.34	.....	52.33	.....	1	2	.....	1	1	.....
Poultry Foods,	294	.....	.....	.....	.....	.....	238	20	24	24	44	12	.....
Rye Bran,	14	10.84	13.79	2.67	4.30	26.33	8	.....	3	3	6	.....	.....
Rye Feed,	1	11.62	13.13	2.67	3.59	32.00	.....	.....	.....	1	1	.....	.....
Rye Middlings,	17	12.04	12.18	2.41	2.48	30.94	10	.....	1	6	7	.....	.....
Screenings—Corn,	1	10.10	10.50	9.14	2.70	.....	.....	.....	.....	.....	.....	.....	.....
" Flax,	1	8.84	11.06	6.82	21.02	.....	.....	.....	.....	1	1	.....	.....
" Malt,	1	12.20	23.56	1.41	10.66	28.00	1	.....	.....	.....	.....	.....	.....
" largely weed seeds,	1	8.57	17.06	13.27	9.54	.....	.....	.....	.....	.....	.....	.....	.....
" Wheat,	1	10.54	14.13	2.25	5.53	.....	.....	.....	.....	.....	.....	.....	.....
Star Feed,	2	7.30	8.97	7.05	10.34	29.00	2	.....	.....	.....	.....	.....	.....
Wheat Bran,	90	8.79	15.02	4.52	9.35	28.16	67	6	5	19	17	5	1
Wheat Feed,	7	9.26	15.46	4.69	7.65	28.58	5	.....	.....	2	2	.....	.....
Wheat Middlings,	74	9.71	15.86	4.87	5.00	33.11	55	7	6	8	15	3	.....
Wheat and Rye Middlings,	2	9.47	14.66	5.07	5.51	36.00	2	.....	.....	.....	.....	.....	.....
Wheat Middlings and Maizo Red Dog Flour,	2	8.28	12.60	7.20	4.30	31.50	2	.....	.....	.....	.....	.....	.....

* Average selling price per cwt.

Registrations

During the year fifty manufacturers registered 198 brands which they intended to offer for sale.

Allen Manufacturing Co., Quakertown, N. J.; George M. Andrews & Son, Woodstown, N. J.; Ansbacher Insecticide Co., New York City; Aphine Manufacturing Co., Madison, N. J.; Avri Chemical Co., Jersey City, N. J.; E. J. Barry, New York City; James A. Blanchard Co., New York City; Bowker Insecticide Co., Boston, Mass.; Cinnakol Chemical Sales Co., Bayonne, N. J.; Corona Chemical Co., Milwaukee, Wis.; Danforth Chemical Co., Leominster, Mass.; F. W. Devoe & C. T. Raynolds Co., New York City; The Dow Chemical Co., Midland, Mich.; Felton, Sibley & Co., Inc., Philadelphia, Pa.; Samuel H. French & Co., Philadelphia, Pa.; Garret Oil Co., Philadelphia, Pa.; Grasselli Chemical Co., Cleveland, O.; Hammond's Paint and Slug Shot Works, Beacon, N. Y.; The Handy Torch Co., Utica, N. Y.; Hemingway & Co., Inc., Bound Brook, N. J.; Morris Herrmann & Co., New York City; Interstate Chemical Co., Jersey City, N. J.; F. F. X. Irsa, Amagansett, N. Y.; The Kil-Tone Co., Newark, N. J.; Fred L. Lavanburg, New York City; Arthur Laver, Bernardsville, N. J.; Lebanon Chemical Co., Lebanon, Pa.; Leggett & Brother, New York City; Lehn & Fink, New York City; John Lucas & Co., Inc., Gibbsboro, N. J.; McCormick & Co., Inc., Baltimore, Md.; Mechling Bros. Manufacturing Co., Camden, N. J.; A. Mendleson's Sons, Albany, N. Y.; Merrimac Chemical Co., Boston, Mass.; The Modoc Co., Inc., Fernwood, Pa.; Niagara Sprayer Co., Middleport, N. Y.; Pfeiffer Color Co., Inc., New York City; The Plantlife Co., New York City; Powers-Weightman-Rosengarten Co., Philadelphia, Pa.; B. G. Pratt Co., New York City; The Rex Company, Rochester, N. Y.; Riches, Piver & Co., Hoboken, N. J.; Schering & Glatz, New York City; Schieffelin & Co., New York City; Sherwin-Williams Co., Cleveland O., and Newark, N. J.; Smith, Kline & French Co., Philadelphia, Pa.; Sterling Chemical Co., Cambridge, Mass.; The H. A. Stoothoff Co., York, Pa.; Thomsen Chemical Co., Baltimore, Md.; Vreeland Chemical Co., Little Falls, N. J.

Inspection

Eighty samples were secured by one of our regular inspectors, 74 of which were examined and consisted of: 15 samples of Paris Green, 23 samples of Lead Arsenate, 5 samples of Lime-Sulfur, 6 samples of Bordeaux Mixture, 25 samples of Miscellaneous Brands.

REPORT OF THE DEPARTMENT OF HORTICULTURE

Department of Horticulture

Maurice A. Blake, B.Sc., *Horticulturist.*
Charles H. Connors, B.Sc., *Assistant in Experimental Horticulture.*
Arthur J. Farley, B.Sc., *Specialist in Fruit Studies.*
Lyman G. Schermerhorn, B.Sc., *Specialist in Vegetable Gardening Studies.*
*Herman J. Levine, B.Sc., *Assistant in Vegetable Gardening.*
†D. Manley Jobbins, *Greenhouse Assistant.*
Louis A. Ruzicka, *Greenhouse Assistant.*
W. Raymond Stone, *Orchard Foreman.*
‡Ralph M. Hubbard, B.Sc., *Field Assistant.*
**David Schmidt, B.Sc., *Field Assistant.*

* Appointed June 1, 1916.
† Died November 9, 1916.
‡ Appointed February 1, 1916.
** Appointed July 1, 1916.

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Report of the Department of Horticulture

M. A. Blake

C. H. Connors

I

INTRODUCTION

The work of the Horticultural Department has followed the same lines as in 1915. The greenhouse experiments with roses and carnations have been continued and much data secured. The lime experiment with Killarney roses, an experiment concerned with the behavior of carnations grown in various types of soil on ground and raised benches, and an experiment to study the behavior of carnations benched at different dates have been completed and will be published as soon as funds and time permit. A study of the gardenia begun in the fall of 1914 gave some very interesting information regarding the growth of this plant last year and the experiment has been extended this year to study the effect of different amounts of lime upon its growth.

The experimental peach orchards at Vineland continue to occupy a large part of the attention of the members of the department. Owing to unfavorable weather conditions during the latter part of the winter and a severe hail storm in June, the orchards did not bear a large crop. The trees in the pruning experiment made a very vigorous growth during their fifth summer because of the exceptionally favorable weather. In fact, the growth was excessive for the development of the best color in the fruit throughout the Vineland district and in many other sections. The light crop born by the varieties Elberta and Stump upon the pruning plots also tended to encourage vegetative growth. The breeding work with peaches is being continued, as will be reported upon further.

A number of varieties of plums have been added to the miscellaneous orchard, and additional plantings of bush fruits and strawberries have been made.

The work of the department has been furthered by the purchase of the Wolpert farm, which will provide space and a soil type to extend and develop the investigational and teaching work with vegetables. It also provides for some much needed extension of the fruit work at New Brunswick.

A number of changes in the staff of the Horticultural Department have taken place during the year. Mr. Lawrence G. Gillam was appointed Extension Specialist in Fruit Growing, February 1, 1916. Mr. John W. Bartlett resigned as Field Assistant to enter the Extension Division as Specialist in Dairying. Mr. David Schmidt was appointed Field Assistant, beginning July 1, 1916. Mr. Ralph M. Hubbard has been appointed Orchard Foreman at the College Farm, with Mr. Paul Sassi as Assistant. Mr. Herman J. Levine has been appointed Assistant in Vegetable Growing.

Mr. D. Manley Jobbins died very suddenly November 9, 1916. Mr. Jobbins began work at the Station in 1908 when the greenhouse equipment consisted of two old wooden frame houses that needed rebuilding, and the "Short Course" greenhouses which had just been completed. He was of great assistance to the Station in the planning and the development of the large range of greenhouses erected in 1911 and 1912. Much of the success of the floricultural work was due to his untiring energy and readiness to do anything that would further the progress of the Station.

The weather and phenological observations for the past season have been taken by Prof. A. J. Farley, assisted by Mr. R. M. Hubbard and H. B. Holcombe.

II

NEEDS OF THE DEPARTMENT

The horticultural division is greatly in need of an appropriate building for the conduct of both instruction and investigation. Such a building would also provide an annual meeting place for the New Jersey State Horticultural Society. There is also urgent need of a building for the storage of spraying machinery, packing tables and horticultural implements of various sorts. Investigational work has been undertaken with vegetables, but there is need of more funds in order to make rapid progress.

A large number of peach seedlings from known crosses have now been propagated and planted, and it is a matter of only a few years before it will require the entire time of at least one man to observe and describe the behavior of these individual trees. It is hoped that some of these seedlings may prove to be of much commercial value.

It is the earnest desire of the Horticultural Department to conduct investigations with strawberries and the bush fruits in order to furnish growers with information comparable to that

provided for the peach growers. This would necessitate the appointment of one or more specialists who could devote their entire time to such studies.

III

VINELAND PEACH EXPERIMENTS

There was a good set of fruit buds upon the experiment orchard in the early winter of 1915–1916. During January, however, a period of extremely warm weather occurred which started the buds to swell. Later a severe sleet storm occurred in the district and the branches and twigs of the trees became thoroughly coated with ice. Several bright days followed, and it was noted that the ice next to the branches and twigs was melting and running down the branches. After the trees were cleared of ice, it was noted that many of the large buds were water-soaked and spongy, and apparently injured by the thawing and freezing of the ice about the twigs. The condition of the buds was somewhat different from any observed following such a slight storm.

The past season gave further evidence that Elberta and other varieties of its group, such as Early Elberta and J. H. Hale, start into growth upon the occurrence of the first warm days in winter and are later injured by cold. Such varieties as Reeves also lost as high as 75 to 85 per cent of their fruit buds during the winter. On the other hand, varieties like Carman and Greensboro, which respond less quickly in periods of warm weather, escaped with slight loss.

The conditions for growth were exceptionally favorable during the early spring and summer, and the trees of all varieties made an unusual growth. In fact, the growth was commonly excessive for the best color of the fruit throughout the Vineland district. On June 11, a severe hail-storm occurred in the Vineland district, doing great damage to crops. The hail-stones were large and cut large holes in many of the fruits. In some of the orchards in the vicinity the damage was very great. In the orchards of Mr. Perkins the fruit was stripped from the trees and the branches and twigs very badly battered.

The whole orchard was sprayed in the usual manner for the control of scale, leaf curl, curculio, scab and brown rot. The frequent rains during the early summer greatly favored the development of the scab, and it was one of the most difficult seasons the growers have experienced in its control. Weather conditions, and the hail injuries, also favored the development of brown rot in this district. The season about Vineland can be described as

unfavorable from the standpoint of the practical grower. The same conditions did not prevail to the same degree in some other sections of the State.

The following spray schedule was practiced in the experiment orchards during the past season:

No. 1—Lime-sulfur for scale and leaf curl, March 18 to 25.
No. 2—Arsenate of lead, May 12, 13.
No. 3—Self-boiled and arsenate of lead, May 26, 27.
No. 4—Self-boiled, June 13, 14.
No. 5—Self-boiled, July 6 to 11, all varieties ripening after August 10.
No. 6—Self-boiled, August 1, late varieties such as Smock and Bilyeu.

The spray applied June 13 and 14 apparently prevented much brown rot in the wounds caused by the hail-storm of June 11.

Peach Yellows and Little Peach at Vineland.—The inroads made by little peach and peach yellows were especially heavy throughout the State during the past season. In the experiment orchards at Vineland, however, the loss was slightly less for 1916 than for 1915. In 1915, 28 trees or 5.02 per cent were lost because of these two diseases, while in 1916, 24 trees or 4.19 per cent were removed. Table I shows the annual loss in Orchard No. 1, with per cent loss, from 1909 to 1916.

Table I

Trees Lost Because of Disease: Orchard No. 1

Year	Yellows	Little Peach	Not Determined.*	Per Cent Loss
1909,	..	..	2	0.3
1910,	..	4	..	0.6
1911,	5	..	..	0.7
1912,	1	4	..	0.7
1913,	8	3	..	1.6
1914,	1	5	..	0.9
1915,	1	3	..	0.6
1916,	8	2	..	1.5
Total,	24	21	2	...
Grand Total,	..	47	..	6.96

* In the early stages of the disease in young trees it is difficult to distinguish between yellows and little peach.

Orchard No. 1 contains 675 trees. The total loss for 8 years is 47 trees or 6.96 per cent of the planting. The loss in 1916 was 10 trees or 1.5 per cent of the total number of trees planted. This is the second largest annual loss. The trees which were removed from Orchard No. 1 during 1916 were the following:

Little Peach: Row 2, Tree 20; Row 4, Tree 24.

Yellows: Row 8, Tree 23; Row 9, Tree 23; Row 9, Tree 24; Row 16, Tree 18; Row 17, Trees 16, 17, 18; and Row 18, Tree 17.

By referring to the diagram in the report for 1915, it will be noted that in two instances trees removed were adjacent to trees that had been removed in previous years. In the case of the trees removed from Rows 16, 17 and 18, trees had been removed from that plot in 1909 and 1910, although not directly adjacent to the trees diseased in 1916.

Table II shows the annual loss from Orchard No. 2.

Table II

Trees Lost Because of Disease: Orchard No. 2

(Including Plots A, B, and C.)

Year	Yellows	Little Peach	Per Cent Loss
1911,	3	4	1.27
1912,	5	4	1.64
1913,	3	10	2.36
1914,	4	14	3.28
1915,	1	20	3.82
1916,	1	5	1.09
Total,	17	57	....
*Grand Total,	74	.	13.45

* Three trees were removed in 1915 after the report for that year had been written.

Orchard No. 2, including Plots A, B, and C, contains 550 trees, so that the total loss for the six years of 74 trees means that 13.45 per cent of the trees planted have been lost because of these two diseases. The loss in 1916, however, is the smallest annual loss. The trees which were removed from this orchard are as follows:

Little Peach: Row 1, Tree 5; Row 2, Trees 2 and 6; Row C, Tree G; Row E, Tree H.

Yellows: Row 27, Tree 16.

Referring again to the diagram in the 1915 report, it will be noted that all the trees removed adjoined areas that had been previously infested. Row 27, Tree 16 is one of five trees of a single variety (Fitzgerald) planted in that row. In 1911, Trees 12 and 14 became diseased with the yellows, and in 1912, Tree 15. Tree 12 is the only tree remaining of the original five.

Table III

Trees Lost Because of Disease: Orchard No. 3

Year	Yellows	Little Peach	Per Cent Loss
1914,	1	..	0.2
1915,	2	1	0.6
1916,	4	4	1.6
Total,	7	5	...
Grand Total,	12	..	2.42

Orchard No. 3 contains 496 trees. The total loss for 3 years of 12 trees or 2.42 per cent is considerably less than the loss from Orchard No. 2 for its first three years, but more than from Orchard No. 1. The actual and per cent losses have increased for each year. The loss for 1916 is relatively great compared with the loss from Orchard No. 1 and is approximately the same as the loss from Orchard No. 2 in the corresponding year of its growth. The following are the trees removed from Orchard No. 3 in 1916:

Little Peach: Row 27, Tree 3 (Row 28, Tree 3); Row 30, Tree 5; Row 31, Tree 7.

Yellows: Row 5, Trees 10, 11, 12; Row 31, Tree 10.

Row 28, Tree 3 was reported diseased in 1915, but was not removed until this year. Nearly all the diseased trees are in the same general area, and one (Row 31, Tree 10) is close to trees that were diseased in 1914 and 1915. Row 5, Trees 10, 11, 12 are isolated from previously diseased trees. It might be well to repeat the statement of last year's report advising the removal of diseased trees immediately upon the discovery of the infection. It is of further interest to state that no tree that has been replanted where a diseased tree has been removed has as yet become diseased at Vineland, and some trees were replanted as early as 1910.

PEACH BORER OBSERVATIONS AT VINELAND.—Continuing observations of previous years, a record was kept of the number of borers found in each tree in the experiment orchards at Vineland. The details of borer observations for 1913, 1914 and 1915 were published in the Station reports of 1914 and 1915.

The experiments with various repellants has been continued, as outlined. Row 1 has received asphaltum. In 1915, a collar was formed close about the base of the tree by making a circular furrow with the finger and pouring asphaltum into this in addition to applying it on the trunk. Row 7 received white lead, Row 13 is a check, Row 19 received government whitewash, Row 25 received "Sulfocide" and Row 26 received concentrated lime-sulfur, 1 to 9. In addition to the above treatments, the trees in Rows 4 and 6, Orchard No. 1, had "Scott Tree Protectors" and the trees in Rows 10, 11, 12 had a modification of the "Scott Tree Protector" made of two-ply tar-paper. The latter protection was applied also to Row 7 in Orchard No. 3. After the borers were removed in 1915 the trunks of the untreated trees in Orchard No. 1 were coated with whitewash and lime-sulfur and the trunks of the trees in Orchard No. 2 with government whitewash.

None of the repellants applied to the trunks gave any measure of protection to the trees with the exception of asphaltum. The reduction in the number of borers in Row 1 seems to indicate that a thorough application of asphaltum to 6 or 8 inches of the trunk with a collar at the surface of the tree, would tend to reduce the number of borers. Thoroughness of applications is vital, however. If the application is too thin, the coating will open as the rough bark expands with growth and there is a tendency to break the coating at the lenticles. Readers of this article should note that a plain asphaltum was used in these experiments and not one of the so-called asphaltum paints.

The borers were removed in 1916 as previously described, two examinations being made. Figure 1 shows a plan of the three orchards and indicates the number of borers that were removed from each tree in 1916. Diagram 1, opposite p. 76 of the Annual Report of the New Jersey Agricultural Experiment Station for 1914, shows the character of the surroundings of the orchards.

In general, the areas that have the lightest infestation are the southwest corner of Orchard No. 1, the center and western border of Orchard No. 2, and the center of Orchard No. 3, a condition which has prevailed since the orchards were planted. Infestation is increasing in the southeast and southwest corners of Orchard No. 3. These areas both adjoin woodland.

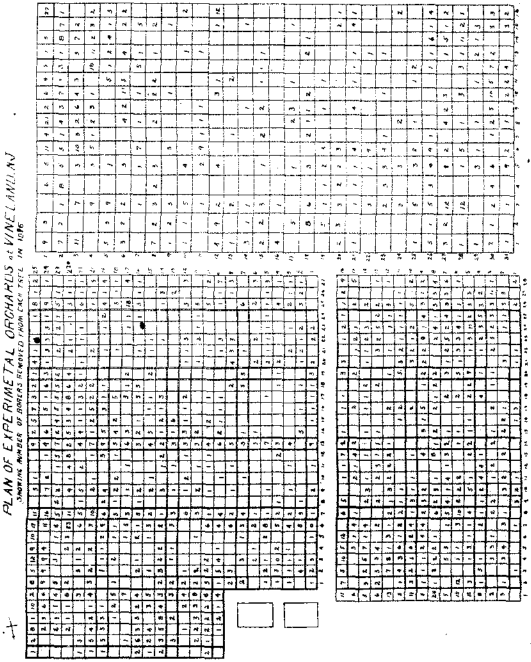

PLAN OF EXPERIMETAL ORCHARDS at VINELAND, NJ
SHOWING NUMBER OF BORERS REMOVED FROM EACH TREE IN 1896

Figure 1

Table IV shows a record of the number of trees infested and the number of borers removed from each row in Orchard No. 1 in 1913, 1914, 1915 and 1916. The infestation in this orchard has decreased by 93 trees, or 16.5 per cent of the trees infested in 1915. The amount of infestation also shows a decrease of 1,649 borers or 59.1 per cent based on the 1915 report. Two rows, 13 and 21, have the same number of trees infested; and Rows 7, 9, 14, 17, 22, 23, 25, 26, 27 had more trees infested in 1916 than in 1915. Only three rows, however, namely, Rows 25, 26 and 27, had more borers than were found in 1915. It will be noted that the number of rows having twenty or more trees infested has decreased from thirteen in 1915 to five in 1916. Of these five, three had more than twenty trees infested in 1915, two having advanced from less than twenty to twenty or more. Row 6 had the largest number of borers in 1913 and 1914, and again takes the lead in 1916. Row 13 has the second largest number, this row having had the most in 1915. There were no rows in 1916 in which more than 200 borers were found. The reduction in the number of borers found in Trees 24 and 25 in Row 1 from 48 and 27, respectively, to 8 and 9 is noteworthy.

Table IV

Record of Borers Found in Orchard No. 1: May, 1913; May, 1914; May, 1915; May, 1916

Row*	1913		1914		1915		1916	
	No. Trees Infested	No. Borers Found	No. Trees Infested	No. Borers Found	No. Trees Infested	No. Borers Found	No. Trees Infested	No. Borers Found
1.	18	35	13	41	23	163	18	48
2.	13	24	15	51	24	156	18	51
3.	12	26	16	54	20	85	18	51
4.	11	22	18	72	25	222	12	28
5.	7	26	18	51	23	200	12	26
6.	16	55	23	115	24	224	23	135
7.	17	42	21	93	24	172	25	105
8.	11	18	22	94	24	200	7	9
9.	16	41	19	92	19	69	20	54
10.	13	31	17	54	22	109	9	12
11.	20	36	21	45	23	113	11	15
12.	11	23	21	77	22	124	10	23
13.	12	23	18	50	24	254	24	118
14.	13	22	13	29	18	70	19	53
15.	8	10	11	31	15	41	13	31
16.	9	14	11	32	16	68	13	86
17.	13	34	13	38	15	74	17	42
18.	11	18	15	47	21	87	14	34
19.	15	29	12	21	16	53	10	22
20.	6	14	15	36	17	73	11	21
21.	10	12	15	31	17	41	17	26
22.	13	23	12	29	12	25	14	26
23.	9	17	17	31	9	21	10	15
24.	8	18	12	37	11	28	9	10
25.	10	12	10	57	16	52	21	93
26.	8	16	9	22	9	14	16	19
27.	16	53	7	11	11	31	18	42
Total,	326	693	423	1311	502	2789	409	1140

* Each row contains 25 trees.

A record by rows for Orchard No. 2 is shown in Table V. This orchard shows an increase of 72 trees infested, or 29.50 per cent more than in 1915, with 256 borers, or 40.2 per cent more than in 1915. As previously noted the trees in this orchard received a coating of government whitewash after the borers had been removed in 1915.

Table V

Record of Borers Found in Orchard No. 2: May, 1913; May, 1914; May, 1915; May, 1916

Row*	1913		1914		1915		1916	
	No. Trees Infested	No. Borers Found	No. Trees Infested	No. Borers Found	No. Trees Infested	No. Borers Found	No. Trees Infested	No. Borers Found
1,	16	20	15	70	15	117	15	130
2,	16	10	12	51	7	22	11	85
3,	11	15	10	22	10	28	10	32
4,	8	14	13	46	6	20	14	47
5,	6	18	11	30	9	22	14	30
6,	6	8	13	36	15	35	10	27
7,	11	22	9	27	9	12	13	32
8,	7	12	12	31	12	57	18	43
9,	3	44	12	20	7	12	13	31
10,	4	7	11	25	7	9	12	28
11,	4	4	10	33	11	24	14	25
12,	3	4	7	12	11	23	7	14
13,	4	7	8	18	7	12	12	36
14,	6	8	14	27	11	20	9	14
15,	7	11	9	16	3	3	10	14
16,	4	8	7	14	3	4	5	6
17,	6	7	9	12	9	14	12	24
18,	4	4	5	8	4	6	7	13
19,	5	5	7	8	4	6	6	10
20,	10	25	12	39	11	27	11	32
21,	4	10	11	21	13	34	0	18
22,	4	6	7	16	11	20	18	22
23,	6	11	12	24	9	16	13	37
24,	4	7	8	12	8	15	15	43
25,	5	8	10	16	6	11	12	26
26,	12	22	8	23	14	35	16	40
27,	6	12	7	23	7	20	9	20
28,	4	13	11	86	5	12	11	34
Total,	186	342	280	766	244	636	316	802

* Each row contains 16 trees.

Table VI

Record of Borers Found in Orchard No. 3: May, 1913; May, 1914; May, 1915; May, 1916

Row*	1913		1914		1915		1916	
	No. Trees Infested	No. Borers Found	No. Trees Infested	No. Borers Found	No. Trees Infested	No. Borers Found	No. Trees Infested	No. Borers Found
1,	9	14	9	28	20	56	22	75
2,	9	11	10	13	22	50	17	52
3,	17	25	21	54	27	187	28	106
4,	11	14	8	12	13	28	9	80
5,	14	21	18	35	28	90	27	87
6,	8	11	14	29	13	28	18	87
7,	5	5	3	5	9	15	11	18
8,	1	3	10	18	23	65	17	52
9,	3	3	7	11	11	29	14	34
10,	6	12	8	10	11	19	15	47
11,	6	6	4	7	11	22	16	43
12,	6	10	11	34	13	28	12	45
13,	3	3	8	9	14	17	20	39
14,	6	8	6	17	14	27	10	50
15,	5	8	9	12	19	48	19	45
16,	7	11	9	25	10	18	15	65
Total,	116	165	153	319	253	727	270	875

* Each row contains 31 trees.

The infestation has increased also in Orchard No. 3, as shown in Table VI. There has been an increase of 17 trees infested, an increase of 6.3 per cent. The number of borers increased 148, or 20.3 per cent.

The "Scott Tree Protectors" were applied to the trees in Rows 4 and 6 in Orchard No. 1, as illustrated in Plate I. These protectors are made of a roofing material and are sealed with a patented preparation known as "Borene," evidently a gas-tar product.

The number of borers in Row 4 was reduced from 222 in 1915 to 28 in 1916, a reduction of 87.4 per cent. The borers found in Row 6 were reduced from 224 in 1915 to 135 in 1916, a reduction of 39.7 per cent. These figures tend to show that the "protectors" were of considerable protection to the trees until we examine the results in Row 5, which show that from a total of 200 borers removed in 1915 the number was reduced to 26 in 1916 or 87 per cent. In other words, the natural reduction of borers in this orchard was great in 1916. A modification of the "Scott Tree Protector," made of two-ply tar paper at a cost of about 1½ cents, and sealed with asphaltum, was applied to the trees in Rows 8, 9, 10 and 11. The reduction in the number of borers in the case of Row 8 was 95.5 per cent; of Row 9, 39.? per cent; of Row 10, 88.9 per cent; and of Row 11, 86.7 per cent.

These figures also would tend to prove the efficiency of the protectors, if we did not note the conditions in the check row adjoining (No. 12) where the reduction in the number of borers in 1916 was 81 per cent.

The effectiveness of the protectors depends entirely upon the maintenance of a complete seal between the top of the cone of paper and the tree. At the experiment orchards it was found necessary to examine the condition of the protectors frequently, since they became unsealed during the storms and in accidents during cultivation. They also appeared to offer an excellent harboring place for mice close about the tree where they might cause damage by girdling without being observed. The economy of such protectors upon a large scale would appear to be open to doubt since the time consumed in applying them and in more or less frequent repairs would amount to as much as or more than that required by the usual method. Furthermore, the protectors require attention during the ripening season in July and August.

Some tests have been made of destroying borers in peach trees by applying a solution of sodium cyanide to the soil about the trees. It proved effective in destroying the borers, but it is too dangerous a material to recommend for use until further studies have been conducted to determine what amounts are safe for the trees.

ODD FORMS OF PEACHES.—During the season of 1915, a large number of double peaches were found in the Experiment Station orchards at Vineland. Some of these were photographed and are presented herewith. The growing conditions in 1916, however, were such as to cause these freak peaches to drop before maturity.

Double peaches may be developed from two kinds of blooms. The first kind is shown in Plate II, figure 1. The normal peach bloom has one pistil, but in the illustration the pistil has divided

Scott Tree-protector.

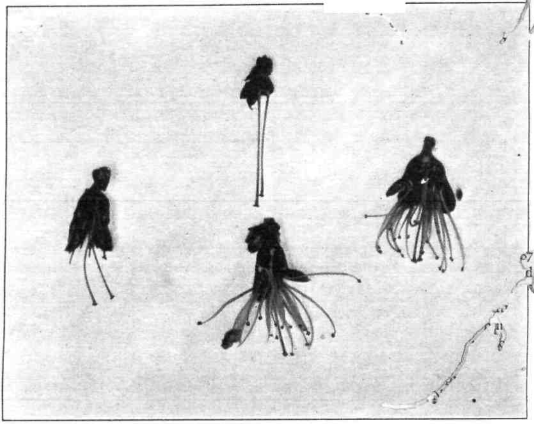


Fig. 1. Single, double and triple pistils.

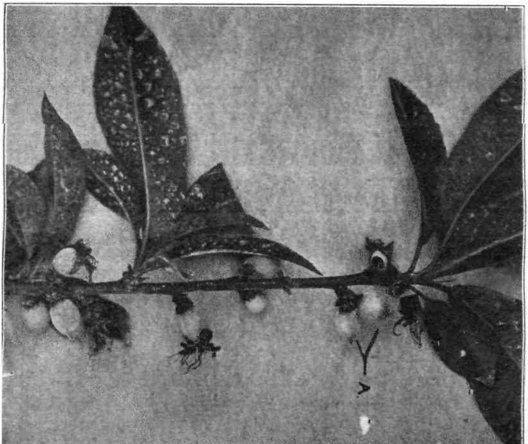


Fig. 2. Peaches set as the result of twin blossoms.

PLATE III

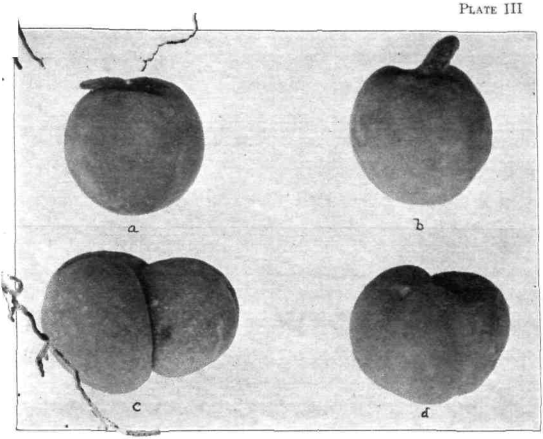


Fig. 1. Fruits of peach from abnormal blossoms.

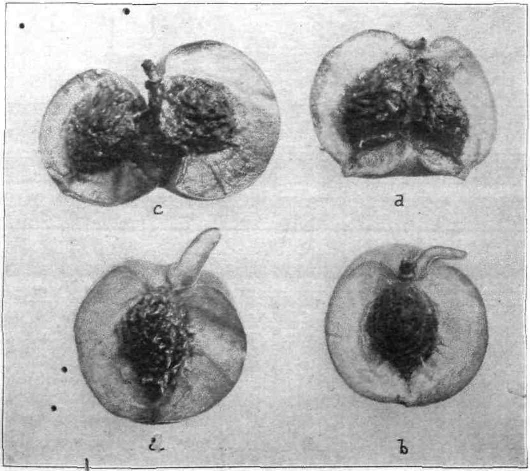


Fig. 2. Cross-sections of fruits shown in figure 1.

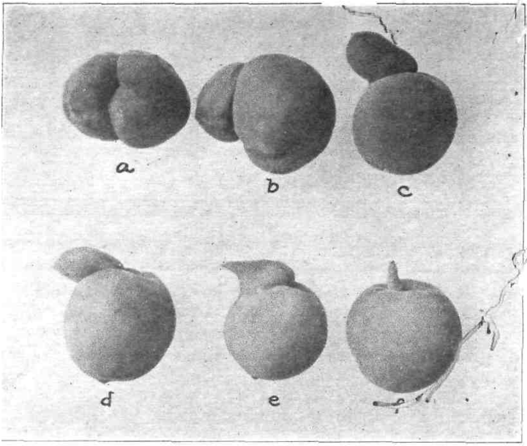


Fig. 1. Fruits of peach from abnormal blossoms to show range in development of secondary fruits.

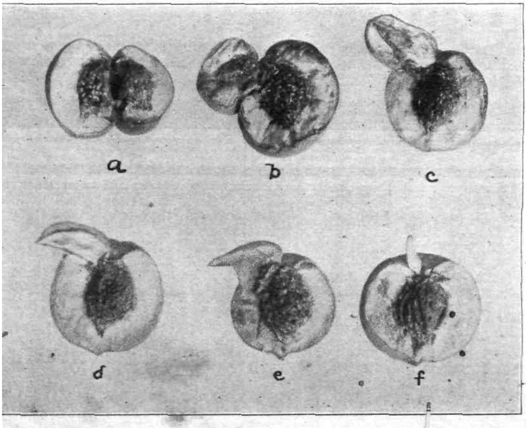
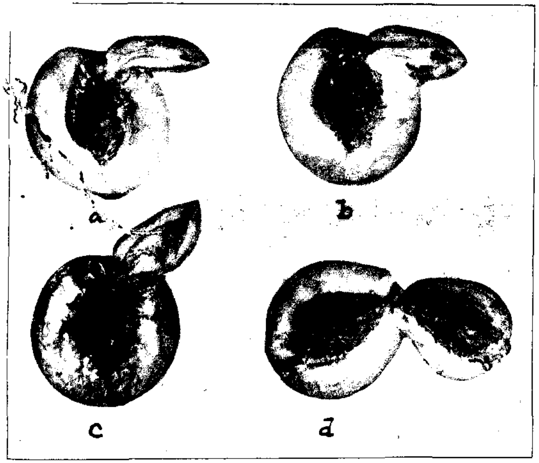


Fig. 2. Sections of peaches shown in figure .



Sections of peaches from abnormal blossoms to show range in development of secondary fruits.

and two have developed. If both of these are pollinated a double peach forms.

The other type of double peach is developed from what may be termed twin-blossoms. Two blossoms each containing the normal number of floral parts emanate from the same stem. This type is shown in Plate II, figure 2, at A, at the stage when the shucks have just been shed.

Double peaches of both types are shown as they appeared when harvested in Plate III, figure 1. The same peaches are shown in section in Plate II, figure 2; *a* and *b* in each figure are peaches from twin blossoms while *c* and *d* are fruits secured from flowers having double pistils. The adhesion of the flesh of the two fruits in *d* is noticeable.

The range in development in what may be termed the secondary fruits is wide, as may be seen in Plate IV, figures 1 and 2, and Plate V. Plate IV, figure 2, shows section of the same fruits as illustrated in figure 1 of the same plate. In Plate IV, figure 2 (f), the secondary fruit is apparently purely vegetative in growth. In the same figure *d* is seen to have a shading somewhat in the form of the stone made by colored fibers. In Plate V, *a*, the horny deposit of the tip of the stone is seen with red fibers outlining the stone. In the same illustration *b* has a still larger tip formed. The development of the stone with the enlarging of the secondary fruit is carried through Plate IV, figure 2 (c), Plate V (c), Plate V (d) and Plate IV, figure 2 (a).

IV

BREEDING WORK WITH PEACHES

The breeding work with peaches has been continued. In the spring of 1916, 403 seedling peach trees were planted on the Wolpert Farm, as follows: Belle Self-pollinated, 134; Belle x Greensboro, 72; Belle x Elberta, 65; Belle x Early Crawford, 39; Elberta Self-pollinated, 6; Elberta x Greensboro, 6; Elberta x Belle, 7; Elberta x Early Crawford, 29; Early Crawford (crossed tree), 45.

In addition to the above, the following seedlings from open-pollinated fruit were planted: St. John, 97; Early Crawford, 24; Late Crawford, 72; Fitzgerald, 4.

These were planted somewhat late and some were planted in rather poor soil, but in general the growth made has been very good.

A large number of seeds secured from crosses made in 1915 were planted in the spring of 1916. From these have been secured the following seedlings in the nursery:

Elberta Self-pollinated,	139	Early Crawford Self-pollinated,	70
Elberta x Belle,	91	Early Crawford x Belle,	28
Elberta x Early Crawford,	51	Early Crawford x Greensboro,	87
Elberta x Greensboro,	110	Early Crawford x Elberta,	42
Belle Self-pollinated,	153	St. John x Early Wheeler,	53
Belle x Elberta,	9	St. John x Greensboro,	25
Belle x Greensboro,	150	Elberta Sport,	85
Belle x Early Crawford,	97	Miscellaneous,	88

In the spring of 1916, a new lot of crosses was made. From the previous work, it was found impracticable to use very early cling-stone varieties, such as Mayflower and Greenboro, as seed parents. Even when the fruits were allowed to remain on the tree until thoroughly ripe, the kernels did not mature to any satisfactory extent.

The crossing this season involved the following varieties: Arp, Carman, Lola, Early Crawford, Slappey and Dewey. A total of 2,265 pits have been put into sand for stratification.

V

BLOOMING DATES OF FRUITS AND ORNAMENTALS

For several years records have been kept of the blooming dates of various fruits and ornamentals on the College Farm and published each year in the annual report. The records for the season of 1916 follow:

Table VII

Blooming Dates of Standard Apples, 1916

Variety	First Bloom	Full Bloom	Variety	First Bloom	Full Bloom
Baldwin,	5-7	5-11	Monmouth,	5-7	5-9
Banana,*	5-9	5-11	Oldenborg,	5-4	5-8
Ben Davis,	5-8	5-11	Rome,*	5-9	5-11
Collins (Stark Champion),*	5-8	5-10	Smith,	5-8	5-11
Delicious,	5-9	5-11	Stayman,*	5-6	5-10
Gravenstein,	5-4	5-8	King,	5-5	5-9
Henry Clay,*	5-4	5-9	Williams,	5-9	5-11
Jonathan,	5-7	5-10	Yellow Transparent,	5-9	5-13
King David,*	5-7	5-10			

* Young trees.

Table VIII

Blooming Dates of Dwarf Apples, 1916

Variety	First Bloom	Second Bloom	Variety	First Bloom	Full Bloom
Alexander,	5-8	5-11	Jonathan,	5-7	5-11
Banana,	5-9	5-11	Oldenburg,	5-4	5-8
Baldwin,	5-9	5-11	Opalescent,	5-8	5-9
Bismark,	5-9	5-10	R. I. Greening,	5-8	5-10
Fall Pippin,	5-6	5-10	Roxbury,	5-8	5-9
Gravenstein,	5-4	5-8			

Table IX

Blooming Dates of Plums, 1916

Domestica

Variety	First Bloom	Second Bloom
Imperial Gage,	5–4	5–5
Italian Prune,	...	...

Japanese

Variety	First Bloom	Second Bloom
Chabot,	4–30	5–2
Wickson,	No bloom	

Hybrids

(South Dakota)

Variety	First Bloom	Full Bloom
Ezaptan,	5–4	5–6
Hauska,	5–1	5–2
Jukpa,	No bloom	
Kaga,	4–30	5–2
Opata,	5–3	5–6
Sapa,	5–2	5–5
Toka,	5–1	5–2

Table X

Blooming Dates of Standard Pears, 1916

Variety	First Bloom	Full Bloom
Seckel,	5–4	5–6
Lawrence,	5–1	5–2
Bartlett,	5–4	5–6
Kieffer,	5–4	5–6
P. Barry,*	5–6	5–8
Garber,*	5–4	5–6
Clairgeau,*	5–3	5–6
Howell,*	5–6	5–8
Lady Clapp,*	5–3	5–6
Col. Wilder,*	5–7	5–9
Jap. Golden Russet,*	5–6	5–8
Sheldon,	5–4	5–6
Wilder Early,	5–5	5–6
Rutter,*	5–6	5–10
Flemish Beauty,*	5–8	5–6
Manning's Elizabeth,*	5–4	5–6
Winter Nelis,*	5–7	5–8
Josephine de Marline,*	5–4	5–6
Buerre Anjou,*	5–2	5–4
Duchess,	5–6	5–8

* Young trees.

Table XI

Blooming Dates of Dwarf Pears, 1916

Variety	First Bloom	Full Bloom
Duchess,	5–3	5–6
Easter Buerre,	5–3	5–6
Buerre Anjou,	5–2	5–4
Louis Bonne,	5–4	5–6
Lawrence,	5–2	5–6
Howell,	5–2	5–6

Table XII

Blooming Dates of Peaches and Nectarines, 1916

Peaches

Variety	First Bloom	Second Bloom
Albright October,	5–2	5–3
Augbert,	5–2	5–3
Beers Smock,	5–2	5–3
Belle,	5–1	5–3
Bray's Rareripe,	5–1	5–3
Carman,	4–30	5–2
Champion,	5–2	5–3
Connetts,	5–1	5–4
Early Elberta,	4–30	5–2
Eaton,	5–3	5–4
Elberta,	4–30	5–2
Elberta (sport),	5–2	5–3
Frances,	5–2	5–3
Hiley,	5–1	5–4
Hottes Elberta,	5–2	5–3
Iron Mountain,	5–2	5–3
Japan Dream,	4–30	5–2

Variety	First Bloom	Full Bloom
J. H. Hale,	5–2	5–3
Lorentz,	5–2	5–3
Mathews,	5–1	5–3
McKay Late,	5–2	5–3
Munson Free,	5–1	5–3
Pride of Franklin,	5–2	5–3
Rochester,	5–2	5–3
Salway,	5–2	5–3
Slappey,	5–2	5–4
Stump,	5–1	5–3
Susquehanna,	5–2	5–3

Nectarines

Variety	First Bloom	Full Bloom
Downtown,	5–1	5–3
Elruge,	5–2	5–3
Pitmaston Orange,	5–2	5–3

Table XIII

Blooming Dates of Small Fruits, 1916

Currant

Variety	First Bloom	Second Bloom
Black Champion,	5–2	5–8
Cherry,	5–1	5–4
Diploma,	5–6	5–8
Fay's Prolific,	5–1	5–4
Perfection,	5–1	5–4
Pomona,	5–2	5–8
Red Cross,	5–1	5–8
Wilder,	5–1	5–8
White Imperial,	5–4	5–6

Gooseberry

Variety	First Bloom	Second Bloom
Columbus,	5–2	5–6
Crown Bob,	5–3	5–8
Downing,	5–2	5–6
Industry,	5–2	5–8
Josselyn,	5–2	5–6
Keepsake,	5–4	5–8

Red Raspberry

Variety	First Bloom	Second Bloom
Cuthbert,	5–31	6–10
Herbert,	5–31	6–6
June,	5–29	5–31
King,	6–1	....
Louden,	5–31	6–2
Marlboro,	5–28	6–6
Rauere,	5–31	6–2
Ruby,	5–28	5–31

Blackcap Raspberry

Variety	First Bloom	Full Bloom
Black Diamond,	5–27	5–31
Cumberland,	5–28	5–31
Hunt,	5–29	6–2
Kansas,	5–27	5–31
Plum Farmer,	5–28	5–31

Purple Cane Raspberry

Variety	First Bloom	Full Bloom
Cardinal,	6–3	....
Columbian,	6–4	....
Royal Purple,	6–2	6–10

Blackberry

Variety	First Bloom	Full Bloom
Blowers,	5–31	6–8
Early Harvest,	5–29	5–31
Eldorado,	6–1	6–6
Joy,	5–29	6–2
Kenoyer,	6–1	6–6
Kittatinny,	5–31	6–8
Meserean,	5–29	6–2
Robinson,	5–31	6–4
Snyder,	5–30	6–1
Ward,	5–29	5–31
Watt,	5–29	5–31

Table XIV

Blooming Dates of Strawberries, 1916

Variety	First Bloom	Full Bloom
Advance,	5–10	5–24
Americus,	5–4	5–17
Barrymore,	5–10	5–22
Big Joe,	5–12	5–22
Bucks,	5–13	5–22
Carolina,	5–12	5–19
Chesapeake,	5–21	5–29
Collingwood,	5–13	5–22
Columbia,	5–13	5–19
Doris,	5–13	5–26
Early Campbell,	5–4	5–17
Early Jersey Giant,	5–4	5–17
Early Ozark,	5–6	5–17
Ed. Wilson,	5–4	5–17
Emerson Joe,	5–9	5–21
Enormous,	5–6	5–18
Fairfield,	5–6	5–17
First Quality,	5–10	5–17
Forward,	5–10	5–21
Gandy,	5–17	5–26
Helen Davis,	5–6	6–16
Howard's 17,	5–4	5–17
Indiana,	5–10	5–19
Joe,	5–16	5–24
Joe Johnson,	5–10	5–19
John H. Cook,	5–10	5–19
Kellogg's Premier,	5–4	5–17
Kellogg's Prize,	5–11	5–20
Klondike,	5–9	5–19
Lady Corneille,	5–4	5–19
Late Jersey Giant,	5–11	5–22
Marie,	5–10	5–19
Marshall,	5–9	5–18
Mascot,	5–13	5–22
McAlpin,	5–6	5–19
Missionary,	5–4	5–17
Monroe,	5–13	5–24
Nellis Triumph,	5–9	5–17
Onward,	5–12	5–21
Productive,	5–14	5–24
Progressive,	5–4	5–17
Prolific,	5–14	5–24
Rewastico,	5–10	5–21
Sample,	5–10	5–21
Shropshire,	5–10	5–19
Success,	5–9	5–19
Superb,	5–10	5–20
T. R. Hunt Seedling,	5–13	5–22
Twilley,	5–9	5–17
Uncle Jim,	5–10	5–20
Warren,	5–13	5–19
Wm. Belt,	5–4	5–17

Table XV

Blooming Dates of Trees and Ornamentals, 1916

Variety	First Bloom	Full Bloom
Acer platanoides,	4-28	4-29
Acer pennsylvanicum,	5-6	5-9
Acer rubrum,	4-10	4-15
Acer saccharinum,	5-1	5-4
Æsculus carnea,	5-20	5-24
Alnus glutinosa,	4-12	4-15
Berberis Thunbergii,	5-6	5-9
Betula alba, var. papyrifera,	4-28	5-1
Betula populifolia,	5-1	5-2
Calycanthus florida,	5-28	6-2
Celastrus scandens,	5-31	6-4
Celtis occidentalis,	5-8	5-11
Cercidiphyllum japonicum,	4-21	4-24
Cercis canadensis,	5-8	5-12
Chionanthus virginica,	5-31	6-2
Cornus florida, var. rubra,	5-19	5-25
Cornus mas,	4-8	4-18
Corylus avellana,	4-10	4-24
Crataegus Crus-galli,	6-4	6-6
Crataegus Coccinea,	5-11	5-14
Daphne Mezereum,	4-11	4-17
Deutzia crenata wateri,	5-4	5-6
Deutzia scabra,	5-26	5-20
Diervilla florida candida,	5-24	5-29
Evonymus alatus,	5-17	5-20
Evonymus europaea,	6-2	6-4
Forsythia intermedia,	4-24	4-29
Forsythia suspensa,	4-30	5-2
Forsythia viridissima,	4-17	4-21
Gaylussacia resinosa,	5-9	5-11
Ilex opaca,	....	6-14
Juglans cinerea,	5-24	5-26
Kalmia latifolia,	6-6	6-10
Kerria japonica, var. flore-pleno,	5-30	6-2
Koelreuteria paniculata,	7-6	....
Lespedeza sieboldi,	....	9-20
Liriodendron tulipfera,	....	6-12
Lonicera tartarica alba,	5-13	5-15
Magnolia glauca,	5-31	....
Philadelphus coronarius grandiflora,	....	....
Platanus occidentalis,	5-6	5-15
Populus balsamifera,	4-10	4-15
Prunus avium,	5-1	5-4
Prunus pissardi,	4-30	5-4
Prunus pseudocerasus,	5-2	5-6
Prunus serotina,	5-27	5-29
Pyrus (Sorbus) americana,	5-20	5-22
Pyrus (Aronia) arbutifolia,	5-16	5-19
Quercus imbrecaria,	5-6	5-9
Quercus muhlenbergii,	5-9	5-11
Quercus pedunculata,	5-9	5-11
Quercus bicolor,	5-10	5-12
Rhododendron catawbiense,	5-20	5-30
Rhododendron maximum,	5-26	5-28
Rhus canadensis,	5-12	5-15
Rhus typhina,	....	....
Robinia pseudo-acacia,	5-29	5-31
Rosa multiflora,	6-6	6-12
Rosa rugosa,	5-24	5-28
Rosa setigera,	7-1	7-10
Rubus odoratus,	6-14	....
Salix alba,	4-24	4-29
Salix babylonica,	4-24	4-29
Sambucus nigra, var. aurea,	6-6	....
Spirea thunbergii,	6-1	6-3
Spirea Van Houttei,	5-24	5-28
Symphoricarpos racemosus,	6-6	6-10
Syringia vulgaris,	5-9	5-12
Syringia vulgaris Marie Le Graye,	5-20	5-22
Tamarix africana,	5-27	5-31
Ulmus americana,	....	4-12
Vaccinium corymbosum,	5-7	5-11
Virburnum dentatum,	6-6	....
Virburnum Opulus,	5-24	5-28
Wistaria chiensis,	5-10	5-15
Yucca filamentosa,	....	7-17

VI

FACTORS CAUSING THE SPLITTING OF CARNATION CALYCES

In the production of carnations for the cut flower trade, commercial florists lose considerable money because of the tendency of the calyces of certain of the flowers to split, allowing the petals to droop downward. Such split carnations sell for only one-half what they would bring were the calyces not split. Since some of the best commercial varieties produce flowers 25 per cent or more of whose calyces are split at certain seasons of the year a study of the factors causing this trouble is important.

Many theories have been advanced as to the factors causing the splitting of carnation calyces. Wheeler and Adams,[1] as a

[1] Wheeler, H. J., and Adams, G. E. A further study of soil treatment in greenhouse culture. R. I. Exp. Sta. Bul. 128, pp. 183–194, 1908.

result of their fertilizer experiments with carnations, make the following statement: "It appears probable that the character of the manure, as well as the degree of forcing tends to affect the splitting of the calyx." In experiments at the Maryland Experiment Station it was found that 21 per cent of the blooms cut on the bench near the glass on one side of the house were split, while not over 7 per cent were split on the other three benches. Close, White and Ballard,[2] of that station, commenting upon these reresults, make the following statement: "The reason usually assigned for this trouble is that plants hardened off by being grown on soil kept rather dry or by having the growth checked in other ways, are likely to produce a larger percentage of bursted flowers when over-stimulated by addition of rich food or moisture. In this case it was found almost impossible to secure uniform conditions near the glass, the soil drying out badly although receiving a normal supply of water. Many growers find less trouble with this bursting of the calyx when the benches are so placed as to allow a walk between them and the side walls." Connors[3] ascribed the splitting or bursting of the calyces to petalody of the pistils and stamens and the development of adventitious buds within the calyx. This multiplication was affected by abnormal conditions. He found that the proportion of split flowers was apparently greatest when an excess of water was given and concluded that the soil proportions, as affecting the water-holding capacity of the soil, was a factor. Ward[4] seems to assume that the tendency is entirely hereditary in that he suggests for its elimination the selection of seedlings which fail to show a tendency to produce flowers with split calyces.

At the New Jersey Agricultural Experiment Station extensive experiments with carnations have been in progress since 1912. These include variety tests, breeding, soil, fertilizer and date of benching experiments. The monthly and annual yields in all these experiments have been recorded in terms of the number of perfect flowers and the number with split calyces. This furnished a great volume of data for study in connection with the splitting of the calyces. Mr. Harris T. Kille, a senior in Rutgers College during 1915–1916, and employed in the greenhouses during spare hours from study, elected to compile and

[2] Close, C. P., White, Thos. N., and Ballard, W. R., Miscellaneous greenhouse notes, Md. Agr. Exp. Sta. Bul. 127, pp. 243–263, pl. 1–4, 1908.

[3] Connors, C. H., Multiplication of floral parts in the carnation. In N. J. Agr. Exp. Sta. 34th Ann. Rept. 1913, pp. 135–142.

[4] Ward, C. W., 1903, "The American Carnation." De La Mere Co., New York.

study this data as a senior thesis. This thesis material and the records of the Station form the basis of this discussion.

It is quite evident that the splitting of the calyces of carnations is affected both by hereditary and environmental factors.

The carnation exists in the single, medium, double and very double or excessively double forms. The true single carnation has five petals and is not of commercial importance in America. It is the "commercial" or medium double carnation that is grown for the market. Extra double carnations, or "bull-heads," as they are termed by commercial growers, contain a large number of petals (in extreme cases four or five hundred), and the calyces of these are nearly always split.

Multiplication of the floral parts, especially of the ovaries and petals, appears to occur almost without limit and the amount of vegetative growth and expansion inside the calyx is so great that splitting frequently occurs before the buds "show color." Some so-called commercial varieties have a constant tendency to produce these extra floral parts and have the reputation of being much subject to splitting. Connors[5] found that the Pink Enchantress normally had an average of about 64 petals to each flower, while an examination of 150 flowers of this variety with split calyces showed the range in the number of petals to be from 70 to 168, or an average of 84. He states, "In every case the splitting of the calyx was due to the multiplication of the petaloid stamens and in nearly every case there was found one or more adventitious buds."

A station seedling No. 30 is a very attractive, bright red flower, but it has a marked tendency to produce adventitious ovaries and buds within the calyx and is subject to excessive splitting. On the other hand, a variety such as Matchless with *a comparatively small number of petals very seldom splits. In* describing a new seedling an introducer not infrequently makes a statement to the effect that the calyx is strong enough to prevent bursting. No calyx ever formed would be sufficiently strong to prevent bursting if there was much pressure from extra vegetative growth inside the calyx, such as occurs with Seedling 30.

If the percentages of split flowers remained fairly constant for each variety from day to day or from month to month it would be assumed that the tendency to split was entirely hereditary, whether because of the average number of petals being large or because of the tendency to produce extra floral parts.

[5] Connors, C. H., Multiplication of floral parts of the carnation. In N. J. Agr. Exp. Sta. 34th Ann. Rept. 1913, p. 143.

But such is not the case; a considerable amount of fluctuation and variation occurs, and environmental factors undoubtedly play a part.

ENVIRONMENTAL FACTORS.—Varying conditions of heat, light and moisture have a marked effect upon the character of plant growth, influencing the development not only of the foliage and stems, but also of the flowers and fruit. The effect upon the flowers is so marked at times as to change the form and number of some of the floral parts. Certain strawberry varieties which under favorable conditions produce perfect flowers become pistillate in character under unfavorable conditions. The first few blooms of Success if obliged to develop in cool, cloudy weather have been observed to have only the rudiments of petals.

On the other hand, heat, light and moisture conditions which cause a slow development of the flowers commonly tend to increase the number of petals in the flowers of plants that are unstable in the number of floral parts. One not familiar with the practical culture of plants under glass might readily assume that outside weather conditions were of little moment to the florist since the heat and moisture factors are supposedly within his control.

The fact is that plants in a greenhouse are markedly affected by the character of the outside weather conditions. Every season statements appear in the florists' journals that chrysanthemums are early or late, that a certain variety of rose is off-crop, carnations or orchids are scarce or that a certain flower is producing in abundance. These fluctuations are distinct from those brought about by the quantity of stock grown of any variety in any one season or year. The carnation is undoubtedly susceptible to influences of the weather outside the houses.

STUDIES WITH THE EXPERIMENT STATION DATA.—Carnations are commonly benched in August and seldom begin to yield many flowers before October and the season is practically over by the end of June. An attempt was made first from the Station data to determine the percentage of split flowers occurring during the various months of the carnation season. Table XVI gives the total production of flowers and percentages split upon a number of plots of White Perfection, Pink Enchantress and Seedling No. 30 from September, 1913, through June, 1914.

It may be noted that the highest percentage of split flowers of the variety White Perfection occurred during the month of December. This was also true of Pink Enchantress. Seedling No. 30 produced a high percentage of split flowers during Octo-

ber and November. All three produced a high percentage of flowers with split calyces during January. Since the days are short and often dark during the months of December and January, it would appear as though lack of light is a factor in the splitting of the calyces. If such is the case we would expect to find fluctuation throughout the forcing season depending to a considerable degree upon weather conditions. Before discussing these in any detail it is well to note general results for other years.

Table XVI

Monthly Record of Yields and Percentages of Flowers Split During 1913–1914

MONTH	White Perfection		Pink Enchantress		No. 30 Red Seedling	
	No.	% Split	No.	% Split	No.	% Split
August,	...	..	...	..	...	..
September,	5	20	17	0	...	..
October,	182	12	148	9	60	50
November,	138	11	51	6	77	48
December,	204	36	263	35	171	80
January,	417	20	755	26	542	30
February,	291	15	598	18	109	11
March,	611	17	1024	11	761	14
April,	244	10	344	7	603	9
May,	232	0	502	11	590	22
June,	416	16	1237	7	895	15

Table XVII

Monthly Record of Yields and Percentages of Flowers Split During 1914–1915

MONTH	White Perfection		Pink Enchantress		No. 30 Red Seedling	
	No.	% Split	No.	% Split	No.	% Split
August,	...	..	...	..	...	..
September,	...	..	...	..	...	..
October,	...	..	...	..	...	..
November,	175	8	103	1	12	25
December,	384	27	263	9	84	62
January,	353	17	278	13	458	44
February,	279	27	274	18	184	21
March,	381	13	634	10	215	10
April,	560	31	870	35	680	24
May,	550	15	386	11	402	11
June,	795	5	1018	6	1196	24

Table XVII is a record of yields with percentages of split flowers for the season 1914–1915. Greater fluctuations in splitting are noted for this season. Although the percentage of split flowers is high for White Perfection in December, it is also high during February and April. Enchantress shows a very high percentage of split flowers in April, but Seedling 30 again

shows the highest percentage of splitting during December and January.

Attention should be called to the fact that snowfall followed by clear weather might at any time during the mid-winter months result in more light being reflected into the greenhouses than during a similar period of dull weather even in April when the days are longer. Table XVIII is a record of yields and percentages of split flowers for the season of 1915–1916. Enchantress shows a high percentage of split flowers from December to April, inclusive. Matchless, which takes the place of Perfection in the records for the year, shows very few split flowers during any month of the year. Seedling 30 again shows a high percentage of split flowers during December and January.

Table XVIII

Monthly Record of Yields and Percentages of Flowers Split During 1915–1916

MONTH	Pink Enchantress		Matchless		No. 30 Red Seedling	
	No.	% Split	No.	% Split	No.	% Split
August,	...	..	...	..	...	..
September,	127	3	20	0	34	12
October,	247	12	241	2	153	31
November,	141	4	176	1	81	55
December,	254	24	204	3	154	74
January,	692	26	393	2	259	72
February,	540	29	559	5	436	27
March,	3798	28	946	8	144	15
April,	2800	42	924	3	327	44
May,	...	..	...	..	...	..
June,	...	..	...	..	...	..

Although various distinct fluctuations occur, observations indicate in a general way that lack of light increases the percentage of split flowers in carnations.

Periods of Dull Weather.—The weather records describe a day as clear, cloudy, half cloudy or partly cloudy, but this is only an approximate estimate of conditions and is not an exact record of the intensity of light by any means. However, it was the only form of weather notes available for these comparisons, and the discussion in this paper is necessarily made upon this basis. If dark, dull days tend to encourage splitting in carnations then we might expect to find such a condition clearly indicated in the yields.

Table XIX is a tabulation of yields of carnations produced upon benches Nos. 3, 4 and 5 in Houses 4 and 5 at this Station during the seasons 1913–1914, 1914–1915 and 1915–1916 with a

record of the cloudy days compiled from the weather observations at the Station. The results in Table XIX are more or less confusing and contradictory at first examination.

In the season 1913–1914 there was a high percentage of cloudy weather during October and November and the yields show a marked increase in the percentage of split flowers during December. There was also a high percentage of cloudy weather during January of the same season, yet the percentage of split flowers the following month decreased.

In the season of 1914–1915 a high percentage of cloudy weather occurred during December and January, and there was an increase in the percentage of split flowers from December to February. However, in 1915–1916 a period of quite clear weather occurred during November and December, and yet the percentage of split flowers increased.

Table XIX

Comparisons of the Yields and Percentages of Carnations Split During Three Seasons, with the Percentage of Cloudy Days

MONTH	1913–14			1914–15			1915–16		
	No. Flowers	% Split	% Cloudy Days	No. Flowers	% Split	% Cloudy Days	No. Flowers	% Split	% Cloudy Days
August,	....	..	32	....	..	26	....	..	44
September,	43	7	43	4	0	10	432	2	27
October,	805	13	52	42	33	42	1205	9	26
November,	528	19	52	1144	3	40	929	6	18
December,	1050	44	37	2196	11	60	1350	25	21
January,	2631	26	53	1999	18	60	3005	24	35
February,	2425	17	36	1881	25	48	3200	21	57
March,	4537	19	39	4084	11	23	3020	15	40
April,	2043	11	45	4849	30	38	2838	29	37
May,	2263	14	26	2443	13	44	....	..	..
June,	4968	10	45	2745	9	28	....	..	..

The matter becomes somewhat complicated and involved since the question arises as to what stage in the development of the carnation bud the dull weather or lack of light would be influential in causing splitting. Seedling No. 30 is notable as a variety which produces many adventitious buds within the flowers, and this consistently shows the highest percentage of splitting during the months of December and January each year. While the stem is growing and previous to the setting of a bud it is very doubtful whether either weather or growing conditions would be a factor in the splitting of the calyx later.

Mr. Kille conducted a study during the season of 1915 and 1916 to determine the number of days required for a carnation

bud to develop from one stage to another, the results of which will be published in detail in another article. He observed that the buds sometimes began to split three or four days after the sepal tips separated sufficiently to expose the petals. This, upon an average, proved to be about 25 days before the flowers were ready for cutting. Since actual splitting of the calyx may begin at least 25 days before the flower is fully expanded, we must conclude that the factor causing the extra floral development must have been in evidence sometime in advance of that period. We may well ask what are the limits in bud development in which extra development of floral parts may be influenced by any factor of environment.

OTHER FACTORS.—It has been observed that splitting of the calyx is likely to occur if the buds are seriously checked in development. When any factor causes the buds of Enchantress to develop in a more globular form than normal there is a high percentage of split flowers. In fact, a globular-shaped bud almost invariably splits. Aphis may sometimes injure a bud so that it is squatty and deformed. The calyx is abnormal in form and probably hardens and loses some of its elasticity of growth previous to the expansion of the bud, and splitting follows. Any factor which results in a severe check or hardening of the calyx previous to the appearance of the petals would tend to encourage splitting. Extra rapid vegetative growth following a period of relatively slow development often results in the rupturing of plant tissues if there is pressure from the inside outward. It is possible that some splitting occurs following dull periods as a result of the very sudden expansion of the petals. It has been observed in the case of Seedling 30 that, if kept dry so that the flowers are relatively small, the percentage of splitting is greatly decreased. This commonly occurs with all carnations late in the forcing season. It is believed that both heredity and environmental factors are concerned in the splitting of the calyces of carnations, and investigations are now being conducted at this Station in an attempt to secure further data.

INFLUENCE OF SOIL, TYPE OF BENCH CONSTRUCTION, AND OTHER FACTORS.—Regardless of the actual causes of the splitting of the calyx, practical growers will be interested to note the effect of different soil types, date of planting and other features of greenhouse management upon the percentage of flowers split.

STUDIES WITH DIFFERENT SOIL TYPES.—Beginning with the season of 1914–1915 some experiments were planned with soils

of widely different types, and a study of the percentage of split flowers produced upon these types should prove interesting. The types of soil used were the red shale, a dense, compact soil; a medium sandy loam and a very light Norfolk sand type. The latter was almost a white "cutting" sand with a little organic matter, and was taken from the surface of a neglected field upon which only a few dewberry briars were found growing. In other words, it was too thin and poor to produce farm crops at the time it was selected. Each of these types was also prepared with about 20 per cent of composted cow manure. All the types and mixtures were represented by at least two plots and the results as to the percentages of split flowers are given in Table XX:

Table XX

Effect of Three Soil Types and the Addition of Compost on the Percentage of Flowers Splitting

Season.	Soil Type.	Treatment.	Split.	Good.	Total.	% Split.
1914-15,	Red Shale,	No Compost,	224	1159	1383	16
1914-15,	Red Shale,	Compost,	250	1490	1740	14
1914-15,	Sandy Loam,	No Compost,	236	1145	1381	17
1914-15,	Sandy Loam,	Compost,	262	1356	1618	16
1914-15,	Sandy,	No Compost,	257	1256	1513	17
1914-15,	Sandy,	Compost,	196	1501	1696	12
1915-16,	Red Shale,	No Compost,	176	479	655	28
1915-16,	Red Shale,	Compost,	173	463	636	27
1915-16,	Sandy Loam,	No Compost,	127	498	625	20
1915-16,	Sandy Loam,	Compost,	163	521	684	24
1915-16,	Sandy,	No Compost,	196	533	729	27
1915-16,	Sandy,	Compost,	190	524	714	27
1914-15,	Av. of 3,	Soils,	717	3560	4277	17
1914-15,	Av. of 3,	Soils with Compost,	708	4353	5061	14
1915-16,	Av. of 3,	Soils,	499	1510	2009	25
1915-16,	Av. of 3,	Soils with Compost,	526	1508	2034	26

During the season 1914–1915 there was an average of 16 per cent split upon the red shale, 17 per cent upon the sandy loam and 17 per cent upon the very light sandy soil, these results showing practically no difference between the widely different types. The addition of compost to these soils gave results as follows: Shale and compost, 14 per cent split; sandy loam and compost, 16 per cent split, and sandy soil and compost, 12 per cent split. While some variation occurs there is little ground for concluding that either the soil type or the addition of compost was a factor in the splitting of the flower.

The experiment was continued upon the same soils in 1915–1916 and the percentage of splitting was higher in general. As to individual types the results were as follows: red shale, 28 per cent split; sandy loam, 20 per cent; and light sand, 27 per cent. The compost plots showed results as follows: shale with compost, 27 per cent split; sandy loam with compost, 24 per cent; and light sandy soil with compost, 27 per cent.

Considered together and covering two seasons, the results are remarkably uniform and very convincing that the soil type in this case had no influence upon the percentage of split flowers.

ADDITIONAL SOIL STUDIES.—A number of other soil studies were being conducted with carnations and since the yields were recorded in terms of perfect flowers and those with split calyces, it will be of interest to note the results.

A mixture of red shale soil with 30 per cent of sand added had shown itself to be a good combination for carnations in

Table XXI

Record of Yields and Percentage of Split Flowers With Carnations Upon Various Soil Mixtures

VARIETY PINK ENCHANTRESS. SEASON 1913-1914.

MONTH.	Shale 10% S, 10% C.		Shale 30% S, 40% C.		Shale 30% S, 30% C.		Shale 30% S, 20% C.		Shale 30% S, 10% C.		Shale 30% S.	
	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.
September,	0	4	0	2	0	4	0	2	0	3	0	5
October,	12	26	9	27	8	24	6	17	11	36	5	22
November,	6	16	14	7	0	8	0	5	17	6	0	7
December,	25	47	37	54	39	38	39	40	36	39	33	36
January,	19	131	22	149	26	99	38	133	28	115	25	128
February,	16	99	19	93	16	120	23	91	15	99	24	96
March,	8	166	15	156	8	166	12	177	18	161	10	198
April,	9	14	5	61	11	54	5	62	8	60	2	43
May,	8	113	8	88	17	80	8	82	12	68	12	65
June,	2	430	5	355	3	232	3	371	4	378	6	375
	No. Split.	No. Per.	No. Split.	No. Per.	No. Split.	No. Per.	No. Split.	No. Per.	No. Split.	No. Per.	No. Split.	No. Per.
	98	914	125	863	104	719	133	855	124	843	120	855
Per Cent. of Total Split	10		13		13		13		13		12	

S. = Sand. C. = Compost. Per. = Perfect.

previous experiments; so it was adopted as a basis mixture and different amounts of composted manure were then added to form the combinations listed in Tables XXI and XXII. The variety Enchantress was grown upon one series of plots and White Perfection upon the other. The results with Enchantress during the season 1913–1914 are given in Table XXI and those with Perfection in Table XXII. The averages for the entire season upon Enchantress were remarkably close, since four plots had the same percentage of split flowers (13) and the

two others showed 10 and 12 per cent, respectively. There was considerable difference in texture between a soil containing 10 per cent of compost and one containing 40 per cent, yet it apparently had little effect upon the splitting of the calyces. Some variation between the plots was noted from month to month, yet there was no consistent advantage shown by any one of the soil mixtures. The results with White Perfection were not quite as uniform as with Enchantress, but with the exception of one plot there were no marked differences. It

Table XXII

Record of Yields and Percentage of Split Flowers With Carnations Upon Various Soil Mixtures

VARIETY WHITE PERFECTION. SEASON 1913-1914.

MONTH.	Shale 30% S.		Shale 30% S. 10% C.		Shale 30% S. 20% C.		Shale 30% S. 30% C.		Shale 30% S. 40% C.		Shale 10% S. 10% C.	
	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.
September,	..	..	..	..	100	1	..	..	..	..	..	..
October,	18	32	18	22	17	41	0	26	6	35	11	26
November,	12	24	8	26	4	26	14	21	14	14	15	27
December,	23	34	45	20	36	36	41	39	22	32	50	34
January,	13	73	20	67	22	91	22	58	18	78	28	50
February,	14	43	16	49	14	49	15	52	11	46	21	52
March,	17	89	19	97	25	112	13	97	10	121	21	95
April,	12	58	12	41	2	44	12	32	10	31	11	38
May,	0	66	0	42	0	47	0	49	2	44	0	42
June,	9	206	3	252	4	288	4	218	6	263	3	202
	No. Split.	No. Per.	No. Split.	No. Per.	No. Split.	No. Per.	No. Split.	No. Per.	No. Split.	No. Per.	No. Split.	No. Per.
	73	552	73	552	89	616	64	528	60	599	80	487
Per Cent of Total Split	12		12		13		11		9		14	

S. = Sand. C. = Compost. Per. = Perfect.

was interesting to note, too, the uniformity of the plots during May when none of the flowers were split, except upon one plot. There was also marked uniformity between certain plots at other periods. Any differences which occur are apparently due to factors other than the soil combinations.

Still another series of soil mixtures composed largely of shale with varying proportions of sand furnish data. Table XXIII gives the results with Enchantress for 1913-1914, and Table XXIV those with White Perfection. The highest percentage

of split flowers occurred upon the red shale plots, with both Enchantress and Perfection and there was a slight decrease with the 10 per cent sand and the 20 per cent sand mixtures, respectively. The shale and 10 per cent compost mixture showed a fairly high percentage of split flowers. While these results tend to indicate that the character of the soil may have some influence, the evidence is so slight in comparison with the other results that it can be given but little weight. The yields upon these same soil mixtures for the season of 1912–1913 could be published, but they furnish only added evidence that the soil mixture within quite wide limits has comparatively little influence, if any, upon the splitting of the calyx.

Table XXIII

Record of Yields and Percentage of Split Flowers With Carnations Upon Various Soil Mixtures

VARIETY PINK ENCHANTRESS. SEASON 1913–1914.

MONTH.	Shale 10% C.		Shale 40% S.		Shale 30% S.		Shale 20% S.		Shale 10% S.		Shale.	
	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.
September, ...	0	2	0	3	..	..	0	1	0	1	0	1
October, ...	3	35	7	29	0	27	0	28	0	18	3	34
November, ...	62	8	7	15	33	6	0	4	33	9	0	9
December, ...	36	18	26	31	23	26	32	34	27	30	38	47
January, ...	27	93	9	92	10	115	12	113	18	108	23	123
February, ...	24	73	19	88	10	108	19	108	12	97	18	84
March, ...	20	145	7	170	10	198	5	177	10	191	15	151
April, ...	8	60	7	73	5	54	0	43	4	48	8	66
May, ...	8	66	6	68	17	69	17	77	4	69	9	87
June, ...	4	169	2	320	5	326	3	347	3	323	8	250
	No. Split.	No. Per.	No. Split.	No. Per.	No. Split.	No. Per.	No. Split.	No. Cut.	No. Split.	No. Cut.	No. Split.	No. Cut.
	104	574	63	744	91	848	80	852	76	818	118	754
Per Cent of Total Split	15		8		10		8		9		13	

S. = Sand. C. = Compost. Per. = Perfect.

GROUND *vs.* RAISED BENCHES.—Since a test is also being made of certain types of bench construction at the Station greenhouses, data was available as to the yields and percentages of split flowers upon a ground and a raised bench. The ground bench was a low cement bench with 18-inch sides and cypress boards for the bottom. The raised bench was of wood construction above a concrete base and elevated so as to permit a good circulation

of air beneath it. The results appear in Table XXV. There were 5 per cent more split flowers upon the raised bench in 1914–1915, and 7 per cent more in 1915–1916. Here a slight consistent difference may be noted, but no definite conclusions are drawn from these results at this time. The plants developed somewhat more rapidly and produced more flowers early upon

Table XXIV

Record of Yields and Percentage of Split Flowers With Carnations Upon Various Soil Mixtures

VARIETY WHITE PERFECTION. SEASON 1913–1914.

MONTH.	Shale.		Shale 10% S.		Shale 20% S.		Shale 30% S.		Shale 40% S.		Shale 10% C.	
	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.
September, ...	..	..	0	2	..	..	..	..	0	1	..	..
October, ...	5	21	7	31	16	20	13	17	4	26	12	32
November, ...	12	8	6	16	6	15	17	21	18	22	5	20
December, ...	52	23	36	30	34	35	26	27	37	30	29	27
January, ...	27	40	23	39	16	37	12	14	20	40	13	44
February, ...	49	33	18	49	10	49	24	41	13	51	27	40
March, ...	41	75	13	54	11	75	15	60	13	66	23	70
April, ...	21	80	6	85	1	78	4	74	7	85	6	72
May, ...	8	[illegible]8	4	56	2	43	0	30	13	23	5	37
June, ...	5	174	5	198	5	212	6	198	4	202	4	232
	No. Split.	No. Per.	No. Split.	No. Per.	No. Split.	No. Per.	No. Split.	No. Per.	No. Split.	No. Per.	No. Split.	No. Per.
	101	389	56	504	49	524	49	453	58	488	62	512
Per Cent. of Total Split	21		10		9		10		11		11	

S. = Sand. C. = Compost. Per. = Perfect.

Tabie XXV

Effect of Ground and Raised Benches Upon the Percentage of Carnations Splitting

SEASON	Bench	Split	Good	Total	% of Total Split
1914–15, ...	Ground, ...	576	4106	4682	12
1914–15, ...	Raised, ...	850	4010	4840	17
1915–16,*	Ground, ...	437	1564	2001	22
1915–16,*	Raised, ...	583	1410	1993	29

* *Through February, 1916.*

the raised bench, as the soil dried out more rapidly after each watering. Since the experiment is being continued, more data will be available in another season.

Effect of Benching at Different Dates Upon the Splitting of the Calyces.—An experiment was undertaken in 1913–1914 to observe the effect of benching carnations at different dates during the summer and late fall. The variety selected was Enchantress. The first lot of plants was benched July 15, and other lots were taken into the greenhouse from the field at intervals of two weeks until September 30.

Table XXVI

Effect of Benching Date on Percentage of Flowers Splitting

Plot Benching Date		1 & 9 July 15	2 & 10 July 30	3 & 11 Aug. 15	4 & 8 Aug. 30	5 & 7 Sept. 15	6 & 12 Sept. 30
1913–14, ...	Split, ...	62	53	67	91	91	117
	Good, ...	556	545	450	634	494	387
	Total, ...	618	598	517	725	585	404
	% Split, ...	10	9	13	13	15	29
1914–15, ...	Split, ...	80	78	131	110	109	92
	Good, ...	687	564	526	517	462	488
	Total, ...	767	642	657	627	571	580
	% Split, ...	10	12	20	18	19	16
1915–16 Through February, ...	Split, ...	69	64	67	52	47	20
	Good, ...	337	351	288	315	215	104
	Total, ...	406	415	355	367	262	124
	% Split, ...	17	15	19	14	18	16
3-Year Average, ..	Split, ...	211	195	265	253	247	229
	Good, ...	1580	1540	1264	1466	1171	979
	Total, ...	1791	1735	1529	1719	1418	1208
	% Split, ...	13	11	17	15	17	19

Comments and observations at this time are based wholly upon the percentage of split flowers produced. The plants were set into a ground bench with cement sides the first season, and the rate of growth was quite uniform. In 1914–1915 the bench was raised and the early-benched plants responded more quickly. For the season of 1915–1916, heating pipes were placed under this bench in an attempt to cause it to dry out more rapidly. More marked differences in behavior between the plots occurred during the last season than previously. Table XXVI is a record of the yields, the number of split flowers, and the percentage split upon these plots for three seasons.

For the first season, 1913–1914, the earlier-benched plants had the lowest percentage of split flowers for the season, and the plot benched September 30 had the highest. In total number of flowers split the last three lots benched lead in 1913–1914.

For the season 1914–1915, the early-benched plots again showed the lowest percentage of split flowers, but in 1915–1916 the difference was not perceptible. The average for three years shows that the plants benched July 15 and July 30 have the lowest percentage of flowers split. This is partially explained by an examination of Tables XXVII and XXVIII, which give the yields by months, and the percentage split from September to February, inclusive, 1915–1916.

Table XXVII

Effect of Benching Date on Time of Yield and Percentage of Flowers Splitting

September 1 to March 1, Season 1915–1916.

Plot No. ...	1		2		3		4		5		6	
Benching Date ...	July 15.		July 30.		Aug. 15.		Aug. 30.		Sept. 15.		Sept. 30.	
Month.	No. Cut.	% Split.	No Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.
Sept., ...	2	0	36	0	6	0	1	0	......	......	......	......
Oct., ...	7	0	31	0	21	5	3	0	......	......	......	......
Nov., ...	29	3	16	6	16	0	17	0	2	9	......	......
Dec., ...	28	14	34	32	21	29	19	21	19	16	3	100
Jan., ...	62	34	78	18	69	20	51	16	32	16	16	6
Feb., ...	55	35	60	32	75	27	86	14	70	21	44	16
Total, ..	183	......	257	......	208	......	177	......	123	......	63	......
% of Total Split, ...	......	21	......	18	......	20	......	14	......	10	......	17

There was not a single case of a split calyx among the flowers produced during the month of September, 1915, and only a very few among those cut during October, 1915. The first flowers produced in the early fall are smaller than those produced later, and this probably explains the absence of splitting. The yield in November, 1915, also showed a very small percentage of split flowers. Therefore, the plots which were benched early produced a considerable number of flowers before splitting became prevalent. In this particular season, however, the percentage of splitting became very high upon these same plots in the months of January and February, while it was less severe upon the late-planted plots. The amount of splitting upon Plots 2 and 10 was high in December, yet comparatively low upon Plots 1 and 9, while the reverse is true in January. This is be-

lieved to add strength to the theory that dark, dull weather has a pronounced effect upon the percentage of splitting when it occurs at a certain stage in the development of the bud, while at other times its influence is slight.

Tables XXVII and XXVIII are included in this discussion to show the detailed behavior upon the various plots and their duplicates.

It will be noted that in the first series of plots, 1 to 3 show a relatively higher percentage of split flowers than is the case of plots 9, 10 and 11 in the second series, and that the reverse is true of the last three plots in each series.

Table XXVIII

Effect of Benching Date on Time of Yield and Percentage of Flowers Splitting

September 1 to March 1, Season 1915–1916.

Plot No.	9		10		11		8		7		12	
Benching Date	July 15.		July 30.		Aug. 15.		Aug. 30.		Sept. 15.		Sept. 30.	
Month.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.	No. Cut.	% Split.
Sept.,	9	0	4	0	1	0	1	0	......	......	......	......
Oct.,	18	6	19	0	3	0	8	0	1	0	......	......
Nov.,	33	0	17	6	11	0	24	4	10	0	......	......
Dec.,	39	15	4	25	10	0	24	4	37	16	6	16
Jan.,	55	13	35	14	47	17	39	13	26	15	19	16
Feb.,	69	23	79	15	75	24	94	22	65	21	36	14
Total,	223	......	158	......	147	......	190	......	139	......	61	......
% of Total Split,	......	13	......	12	......	18	......	15	......	17	......	14

Although a greenhouse is enclosed with glass, there may be marked differences in the amount of light which reach various parts of a house during the day, and the growing conditions certainly vary. There are as great differences between plots and their duplicates as between different treatments in these observations.

The somewhat general, but extensive, observations at this Station seem to indicate that the splitting of the calyces of carnations is influenced by both hereditary and environmental factors; that dull, dark weather and lack of light at certain stages in the development of the bud become active factors in the matter. Differences in type of bench construction, time of placing the plants in

the benches and differences in soil mixtures within ordinary limits have had comparatively little, if any, influence in the splitting of the calyces of carnations at the New Jersey Agricultural Experiment Station greenhouses.

VII

TRUCK CROP ORGANIZATION IN MONMOUTH COUNTY, NEW JERSEY[1]

One of the most prosperous farming areas on the Atlantic seaboard has been and is Monmouth County, New Jersey. It is located on the east central coast of the State, has a total population of 94,734 and an area of 306,560 acres. In farms, there are 206,856 acres of which 156,583 are improved. According to the 1910 Census there were 2,941 farms, averaging 70.3 acres to the farm, 53.2 acres of which were improved. The total value of the farms in 1910 was placed at $14,803,850.00.

Farming has been the dominating industry of this county ever since it was first settled, and, with the exception of a very few periods in its history, the farmers have always been prosperous. There are, however, as is usually the case, both good and poor lands and highly and poorly developed farming communities within this county.

To a large extent, the type of farming carried on is trucking run in conjunction with the production of some of the general farm crops such as corn, hay and forage, and rye, to be sold, or to maintain fertility, but mostly to feed to stock. It is from such crops as potatoes, beans, lima beans, asparagus and peppers that the farmers derive their chief income. The 1909 Census gives the following statistics on the value of crops grown in this county:

Vegetables,	$2,001,775 00
Cereals,	1,002,818 00
Hay and forage,	630,470 00
Fruits,	385,140 00
Dairy receipts,	458,405 00
Poultry and eggs,	329,971 00
Animals slaughtered,	137,323 00

Of the total value of farm products vegetables represent 45 per cent.

The labor supply is plentiful and efficient. It is probably due to this and to the facts that the soil is adapted to culture that the transportation and marketing facilities are exceptionally good, and that land is highly valued, that an intensive system of culture prevails. The yields attained through this practice are very good, the averages according to the 1909 Census being:

	Bushels per Acre.
Potatoes,	128
Corn,	45
Wheat,	22

[1] A thesis study prepared by S. I. Horn, a senior in Rutgers College during 1916. Data from which the tabulations in this paper were compiled were furnished by Prof. Frank App, who also supervised the thesis study.

In general, we find the farmers throughout the county adapting their rotations to the type of soil on their farm. For example, we find potatoes grown, where possible, on the well drained loam and sandy loam members of the Colt's Neck, Sassafras and Collington series. Sandy soils are used for asparagus, well-drained loams and sandy loams for tomatoes, and sandy soils and friable loams for peas and limas. Peppers are adapted usually to sandy soils and seem to do as well on Keansburg sandy soils as on the well-drained sandy soils of the Sassafras series.

Good farm practice is the rule; deep plowing, frequent cultivation, profitable fertilization and good crop rotations giving excellent returns.

In 1909 the corn crop reached 1,099,656 bushels. The plantings of this crop usually follow grass on well-drained and well-prepared soils.

The planting of potatoes by machine begins around March 20 and April 1, and is completed usually by the middle of April. The variety most planted is the American Giant, a heavy, scab resistant variety grown on over 75 per cent of the total potato growing area in the county. The Irish Cobbler and Green Mountain are next in importance. The seed potatoes are obtained chiefly from New York State and Maine. Large amounts of fertilizer are applied, the usual practice being to use 1,200 to 2,000 pounds of a 4–8–10 mixture to the acre. Harvesting by means of diggers of the elevator type commences about the middle of July and continues until the last of August.

Asparagus is sown early in the spring in well-fertilized beds. Early the following spring the crowns are transferred to rows 6 feet apart and set 12 inches to 15 inches apart in the row. They are set quite deep, often being 8 inches to 10 inches below the surface. The method of fertilization recommended consists of applying acid phosphate and bone meal or tankage to the seed bed and treating the plants in the rows with 100 pounds of muriate of potash and 300 pounds of tankage several times during the first growing season, to be followed in the fall by a heavy application of manure. After cultivation begins in the spring or after cutting begins, 1,000 to 1,200 pounds of a 4–8–10 mixture are applied. Some cutting begins the second year on roots set when two years old or the third year when yearling roots have been set. Only after the fourth year is cutting continued throughout the entire season, that is, until the latter part of June.

When the plants start in the spring, which is usually in April, the practice is to ridge the rows to a height of 18 inches. By this means the stalks are bleached. They are then cut as soon as the tips appear above ground by knives passed through the ridge. At the end of the cutting season the ridges are torn down, and the land thoroughly cultivated before the remaining shoots start. About July 15 cover crops of soybeans and cowpeas are usually planted to conserve and add to the fertility of the soil. If good practice is followed beds will continue to produce good crops for twelve or fifteen years, and under favorable conditions an annual crop of 1,200 to 1,800 bunches per acre should be expected. The average for the county is 1,063½ bunches per acre. The best varieties for this county are Palmetto and Giant Argenteuil.

Tomatoes are set May 10 to 15, at the rate of 2,500 plants per acre. The main varieties are Earl[illegible] The Earliana, when

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set early, will begin to ripen by July 10. In fertilizing 700 to 1,000 pounds per acre of a 4-7-7 or 4-8-10 mixture are used. Manure is often applied in the hill, especially with early plantings. The system of culture followed is much like that of corn, and need not here be discussed. The early crop of tomatoes is shipped largely to New York and shore resorts, but the later varieties are disposed of locally to canneries and nearby markets.

Peas are planted early in April with drills on well-prepared and well-fertilized land. Harvesting the crop comes usually the second week in July, the vines being mowed and taken to the shelling establishment.

Lima beans are planted from about the middle of June until the middle of August in rows 3 feet apart. Sometimes the planters are prepared to water their fields in dry seasons. Fertilization is liberal. The cultivation consists of hand hoeing several times and light cultivation. Harvesting covers a period of 8 to 10 weeks, sometimes extending until late in October.

Land devoted to peas and beans is kept in cover crops between seasons, rye being a favorite crop for this purpose.

Pepper plants are transferred from the hotbeds as soon as the danger from frosts is past, and are set 15 inches to 20 inches apart in rows on land fertilized with 700 to 1,400 pounds of a 4-8-10 mixture. They are very carefully cultivated until full-sized when the crop is picked, barreled and marketed. The fields are picked over two to four times a season. In handling the late crop care must be exercised to prevent frost injury. The usual method is to pick the peppers at the first sign of frost, and to store them in a cool place under shelter or piled in windrows and covered with straw. By this means marketing may continue even after the plants in the field are killed. A yield of 400 barrels of green peppers per acre is not uncommon, 160 barrels being an average for the county. The varieties recommended are Cheese, Neopolitan, Red Giant, Red King, Chinese Giant, Magnum Dulce, Bull Nose and Squash.

It is the aim in this paper to discuss and compare a number of farms in Monmouth County in order to determine the causes of any variation in profits which may occur, and, if possible, to draw some conclusion as to the relative merits of retail and wholesale methods of marketing as practiced in this county.

In farming, as a rule, the factor that determines which of these two methods of marketing should be employed is usually the cost of labor. Retailing, although higher prices are received for the produce, may often be less profitable than wholesaling because the men and teams used in retailing might be used to better advantage in the field at home. It is the increased labor cost which offsets the increased retail price. Retailing is often the more profitable for the small trucker, as he seldom has enough work on the farm to use his men and horses profitably all the time. But as soon as the size of the farm affords continuous work for men and horses, retailing often must give way to wholesaling unless the return for the time spent in retailing is greater than that for the same time if it were spent in the field.

It was to determine what the conditions regarding this matter were in Monmouth County that a number of farms, owned outright, were selected

at random and divided into three classes composed of those who retailed their produce, those who wholesaled to New York and those who wholesaled to shore places such as Asbury Park, Red Bank and the like. To eliminate any complication of results from the factor of size, the number of farms used in each group was such that the total areas of each group were practically equal. The area of the farms varied from 15 to 40 acres.

The regular Farm Organization and Analysis Blanks as employed by the New Jersey Agricultural Experiment Station in their farm survey were used as the foundation for all the work. Many factors which might have some very definite relation to the question were calculated and compared, as will now be shown.

It is a well-known principle of farm management that the capital invested is a very influential factor in determining profits. No exact figure can be set which will represent the optimum capital to invest, as this varies with the type of farming, the value of land, stock and machinery and many other things. But the ratio of profits to capital invested varies in accordance with the law of diminishing returns, as do so many other ratios. That is to say, profits increased with investment up to a certain point, beyond which profits begin to decrease. What this margin is must be determined approximately by general practice, but finally and exactly by the individual farmer himself.

Table XXIX

Distribution of Capital on Truck Farms

METHOD	Capital Per Farm	Real Estate Per Farm	% of Total	Buildings Per Farm	% of Total	Horses Per Farm	% of Total	Other Stock Per Farm	% of Total	Machinery and Tools Per Farm	% of Total	Feed and Supplies Per Farm	% of Total	Cash Per Farm	% of Total
Retail, ...	$9,350	$7,884	84	$3,130	33	$439	4.6	$263	2.8	$367	3.9	$173	1.8	$223	2.3
Wholesale to N. Y.	9,189	8,071	87	3,428	37	384	4.1	121	1.3	321	3.4	73	0.8	218	2.3
Wholesale to shore,	7,895	6,181	78	3,518	44	460	5.8	303	3.8	417	5.2	173	2.2	359	4.5

Not only do the profits vary with the amount of capital invested, but also with its nature. In considering agricultural capital we may well divide it into two categories. The first of these is productive capital or that capital invested so as to yield returns directly, as land and the like. The second class is non-productive capital or capital not itself bringing return for its use, as buildings, horses, machinery, and so on. Although it is not possible to have productive capital alone, it should be the aim of the farmer not to allow the non-productive capital to become too great in proportion to the productive. The productive capital is the earning capital of the farmer. Hence it is that a farmer with limited capital often augments his profits by mortgaging his farm, or renting more land and so acquiring more productive capital. Table XXIX will show the relation of the different investments in each group of farms taken in this problem.

In considering these comparative statistics we find some interesting variations. The difference in capital per farm between Groups I and II is not enough to consider, but why these groups should have over $1,500 more per farm than Group III is hard to understand, although it is probably due to a lower value of land in this group. The table seems to show this, as only 78 per cent of the total investment is in land in comparison to 84 and 87 per cent in groups I and II, respectively, although each group contains approximately 310 acres. This group also has a greater investment in horses and machinery per farm than either of the other two, which in truck farming is liable to give this group an advantage. A greater amount of cash on hand would tend also to aid the farmers of Group III. The investment in horses and other stock in this group explains the greater value in feed and supplies, and may also explain to a certain extent the investment in buildings. Although stock, as a rule, is out of place on a truck farm, yet the more efficient use of certain crops which may be fed on the farm, and the manure conserved, may add to the final profits of the farmers in Group III.

Before going further, let us consider the relative profits of these divisions. Table XXVII will best show this.

Table XXVII

Relation of Retailing and Wholesaling Farm Products to Farm Profits When Measured by Labor Income

METHOD	Aver. L. I.	No. L. I. $1–$500	No. L. I. $501–$1,000	No. L. I. $1,001–$1,500	No. L. I. $1,501–3,000	No. L. I. Over $3,000	No. Minus L. I.	No. Farms
Retail,	$488	4	7	1	0	0	1	13
Wholesale to New York,	267	4	4	1	0	0	5	14
Wholesale to shore,	1,190	5	3	0	1	2	0	11

L. I.=Labor income.

These figures seem to bear out our conjectures, Group III by far exceeding the other two groups in profits. Of course, there is a possibility that in using so few farms in each group that there have been some selected which may not be truly representative. We find in Group III one farm earning between $1,500 and $3,000 and two others over $3,000. These, of course, if not characteristic of the group, will give incorrect averages. So, also, would the five farms yielding minus labor incomes be undesirable in Group II unless properly considered as representative.

But let us investigate some of the other factors which may produce these variations. The labor question is a very important one. Are the men, horses and machines being used efficiently? This relation is shown with respect to the groups under consideration in the Table XXXI.

Here, again, we find reasons for the larger income of the farmers of Group III. For through the more efficient use of man labor fewer men are required and, as we will find later, the less the man labor costs. The number of horses is practically the same in each group, but again we find Group III getting more crop acres labor per horse than the other groups. The difference in the efficiency of machine labor is in this case unimportant, although Group I is somewhat lower than the other two in this respect.

Table XXXI

Relation of Retailing and Wholesaling to the Amount of Work Done Per Man, Per Horse and Per $100 Worth of Machinery

	No. Men Per Farm	Crop Acres Per Man	Horses Per Farm	Crop Acres Per Horse	Value Machines Per Farm	Crop Acres Per $100 Machines
Retail, ...	2.00	11.9	2.7	8.8	$367	6.49
Wholesale to N. Y., ...	2.25	9.8	2.5	8.8	321	6.88
Wholesale to shore, ...	1.97	14.3	2.8	10.	417	6.74

Without a consideration of the expenses incurred in growing crops, figures on crop yields and receipts would be meaningless. Table XXXII will show the relationship of this factor in the several groups.

Table XXXII

Expenses on Truck Farms

METHOD	Cash labor per acre	Cash labor + board per crop acre	Cash labor + board + owner's time per crop acre	Cash labor + board + owner's time and board per crop acre	Fertilizers per crop acre	Seed per crop acre	Total expense per crop acre
Retail, ...	$15.35	$27.75	$32.64	$39.13	$6.60	$2.39	$45.05
Wholesale to New York,..	17.35	25.38	38.19	46.00	13.64	3.05	58.71
Wholesale to shore, ...	10.59	17.59	26.22	31.40	14.35	2.82	47.78

It will be noted that the total cost of the labor of the hired men and owners varies inversely with the average labor incomes of the groups. Group III, has, as already stated, the lowest labor expense and the highest labor income per farm. Column 5, giving the relation of fertilizer expenses, shows Groups II and III with practically equal acre costs while the farmers of Group I spend less than half as much. This is due, as will later be shown, to the production in this group of only small areas of crops which require heavy fertilization. The large total expense per crop acre of the farms in Group II, seen in Column 7, explains to some extent why that

group yields the lowest average labor income. Although Group III has a larger cost in this case than Group I, we might expect this to be more than offset by the larger yields per crop acre due to the heavier applications of fertilizer in Group III. This, however, is not the case.

Let us now turn our attention to a comparison of the main crops grown in each group. Tables will show the relations and values to best advantage.

Table XXXIII

Acreage, Yield in Value of Crops, by Farms Retailing and Farms Wholesaling Their Crops

METHOD	Acres	Total Yield	Total Value	Acre Yield	Acre Value	Value Per Unit
			SWEET CORN			
Retail I, ...	41.5	254,000 ears	$3,198	6,135 ears	$77.06	1.2c
W. S. to N. Y. II,	25.0	115,000 ears	1,192	4,600 ears	47.68	1.0
W. S. to shore III,	30.5	193,000 ears	1,995	6,325 ears	65.41	1.0
			POTATOES			
I,*	24	1,191 bbl.	$3,106	49.6 bbl.	$129.41	$2.60
II, ...	1	40 bbl.	50	40.0 bbl.	50.00	1.25
III, ...	24¾	1,415 bbl.	3,304	56.7 bbl.	133.49	2.35
			ASPARAGUS			
I, ...	6¾	10,196 bunches	$1,573	1,510 bunches	$233.00	$0.15
II, ...	46½	60,700 bunches	5,722	1,305 bunches	123.00	.09
III, ...	4½	3,500 bunches	475	777 bunches	105.00	.13
			TOMATOES			
I, ...	16¾	5,053 bks.	$1,276	301 bks.	$76.00	$0.25
II, ...	54½	17,375 cr.	7,945	477 bks.	146.00	.30
III, ...	14⅔	10,058 bks.	2,506	688 bks.	171.00	.24
			CARROTS			
I, ...	2⅖	9,894 bunches	$488	4,047 bunches	$244.00	.....
II, ...	2½	360 bbl.	256	144 bbl.	90.00	.....
III, ...	5⅝	8,075 bunches plus 120 bbl.	2,090	....	365.00	.....
			LETTUCE			
I, ...	1/10	1,250 heads	$63	12,500 heads	$630.00	$0.05
II, ...	....	....	....	....	....	.....
III, ...	8½	11,445 doz.	4,125	1,346 doz.	485.00	.03
			LIMAS			
I, ...	3	1,514 bk.	$945	504 bk.	$315.00	$0.62
II, ...	....	....	....	....	....	.....
III, ...	4½	2,020 bk.	1,188	440 bk.	264.00	.59
			RHUBARB			
I, ...	½	2,540 bunches	$64	5,080 bunches	$128.00	$0.02½
II, ...	....	....	....	....	....	.....
III, ...	5¼	9,933 doz.	2,483	1,892 doz.	473.00	.02
			CUCUMBERS			
I, ...	¾	250 bu.	$137	333 bu.	$182.00	$0.54
II, ...	5½	1,050 cr.	335	190 cr.	61.00	.32
III, ...	¼	....	30	....	120.00	.....

Table XXXIII—Continued

Acreage, Yield in Value of Crops, by Farms Retailing and Farms Wholesaling Their Crops

METHOD	Acres	Total Yield	Total Value	Acre Yield	Acre Value	Value Per Unit
			MELONS			
I, ...	6½	480 bbl. plus 2,000 melons	$870	....	$134.00	.....
II, ...	7¾	2,050 cr.	1,745	264 cr.	225.00	.....
III, ...	10¼	605 bbl.	880	59 bbl.	86.00	.....
			PEPPERS			
I, ...	....	126 bk.	$102	....	....	.....
II, ...	8¼	1,525 bbl.	1,110	184 bbl.	$135.00	$0.73
III, ...	2¼	850 bk.	220	377 bk.	97.00	.26
			SWEET POTATOES			
I, ...	4½	295 bbl.	$683	66 bbl.	$152.00	$2.30
II, ...	3¾	120 bbl.	255	32 bbl.	68.00	2.12
III, ...	2⅗	57 bbl.	145	21 bbl.	56.00	2.66
			STRING BEANS			
I, ...	2⅝	448 bu.	$478	166 bu.	$177.00	$1.06
II, ...	....	....	....	....	....	.....
III, ...	3⅝	505 bu.	437	140 bu.	122.00	.87
			BEETS			
I, ...	2¾	18,736 bunches	$551	6,939 bunches	$204.00	$0.029
II, ...	....	....	....	....	....	.....
III, ...	6⅜	8,816 doz.	2,216	1,378 doz.	347.00	.020
			ONIONS			
I, ...	1	450 bk.	$300	450 bk.	$300.00	$0.66
II, ...	....	....	....	....	....	.....
III, ...	3¼	1,080 bk.	740	332 bk.	227.00	.68
			SPINACH			
I, ...	⅛	217 bk.	$63	1,736 bk.	$504.00	.....
II, ...	....	....	....	....	....	.....
III, ...	5⅝	1,115 bbl.	1,227	196 bbl.	215.00	.....
			PEAS			
I, ...	5¼	442 bu.	$784	84 bu.	$139.00	$1.65
II, ...	....	....	....	....	....	.....
III, ...	5	478 bu.	808	95 bu.	160.00	1.68
			EGGPLANT			
I, ...	1/10	205 bk.	$150	2,050 bk.	$1,500.1	.....
II, ...	3¼	725 bbl.	570	223 bbl.	175.00	.....
III, ...	....	....	....	....	....	.....
			TURNIPS			
I, ...	⅛	12 bbl.	$33	96 bbl	$264.00	$2.75
II, ...	6¾	565 bbl.	501	84 bbl.	75.00	.89
III, ...	....	....	....	....	....	.....
			CABBAGE			
I, ...	3⅕	19,480 heads	$558	6,087 heads	$174.00	$0.028
II, ...	....	....	....	....	....	.....
III, ...	6¼	28,000 heads	635	4,480 heads	101.00	$0.029

Here we see that in a majority of the comparisons made Group I excels in both yield and receipts per acre, with Groups III and II ranking second and third, respectively. In this group we also find that the price received per unit of the crops grown is the greatest in all but a very few cases; and these exceptions are really negligible, as the difference in price received is very small. It is significant to note that Group II, which earns the lowest average labor income, gives the lowest acre yield and receipts, and the lowest price per unit of crop sold.

But why should Group III have the greatest labor incomes when the farmers of that group have the largest total expense per acre, and yields and receipts per acre that are lower than those of Group I? The difference in the amount of capital invested is not enough to account for this. The explanation, however, is quite plain when we see that in most of the cases where Group I surpasses Group III in acre yields and receipts, Group I has but a small area devoted to that crop in comparison to the area so used in Group III. Having only such small areas in these crops the total increase in profits over Group III, from such crops, is consumed in increased labor cost or by the use of the rest of the farm in products less profitable than those grown in Group III.

For example, we find Group I growing $^{1}/_{10}$ of an acre of lettuce and selling the total produce for $63.00 or at the rate of $630 per acre. Group III grows 8½ acres of this crop and sells it at $4,125 or at the rate of $485 per acre. It would seem from this that Group III is losing money, but let us consider what Group I is growing on the remaining $8^{4}/_{10}$ acres so as better to compare the total receipts for an equal area.

Table XXXIV

Relation of Retailing and Wholesaling to Total Crop Receipts

Method.	*Crop Receipts.*	*Crop Acres.*
I,	$18,746 00	310
II,	26,030 00	310
III,	27,996 00	310

In order to equal the total receipts for this area, Group I would have to grow a crop yielding $4,125—$63, or $4,062, representing $485 per acre. There are only two other crops besides lettuce grown in this group which yield such high profits per acre, and these are spinach and eggplant grown at the rate of ⅛ and $^{1}/_{10}$ of an acre, respectively. This puts spinach and eggplant in the same class as lettuce. So we see that, although Group I can get higher receipts on small areas for many of the crops grown, yet the total receipts for larger areas are less than those of Group III. Table XXXIV will show this.

To explain how Group III can have higher expenses per acre than Group I and yet receive the highest labor income of all is seen in Table XXXV.

Table XXXV

Relation of Retailing and Wholesaling to Receipts, Expenses and Profits Per Man

Method.	*Total Receipts Per Man.*	*Total Expenses Per Man.*	*Profits Per Man.*
I,	$1,015 00	$537 00	$478 00
II,	900 00	577 00	323 00
III,	1,485 00	682 00	803 00

This shows the efficiency of the labor and farm organization in Group III, for, although the expense per man is the highest in this group, yet this is more than offset by the high return for the labor applied.

Summary

Group III yields the largest labor income of all for several reasons. First, there is the least capital invested and yet more machinery, horses, and cash per farm. The farms in this group are larger, but there are fewer men per farm, a condition which proves that there is greater efficiency in labor in this group. And finally—a fact which is very influential in determining the final results—most of the land and labor is devoted to crops which are the most profitable.

Group I, although it has the lowest total expense per acre and its yields and receipts per acre are the greatest, earns less than half of the labor income earned by Group III, because of the poor proportionment of the area to the crops grown. If larger areas were devoted to the most profitable crops such as lettuce, spinach or eggplant, greater profits would doubtless accrue. This would probably necessitate the application of the man and horse labor now used in retailing to the production of crops. This increase in business, even if the man and horse labor could be spared from the farm, might also necessitate a wholesale business, because of the difficulty of profitably disposing of large quantities of produce by retail methods.

The reasons for the failure of the farmers in Group II are obvious. There is a pronounced lack of efficiency in the handling of the man and horse labor, making the total expense per acre the greatest of all the groups. The yields and receipts per acre of the crops grown are very low in comparison with the other groups. The profits might be augmented by enlarging the individual farms, by growing more of the most profitable crops and, above all, by getting more labor from both horses and men.

Although these data show that wholesaling is the better method of marketing, yet it seems that in this county the greater profits result from that method when accompanied by a good size of business and efficiency in labor.

VIII
WEATHER OBSERVATIONS

ARTHUR J. FARLEY

The weather during 1916 was unusual in several features. The heaviest snowfall occurred upon December 14, with a depth

of 5.25 inches. The greatest volume in any month, however, occurred in March, with a total of 15.5 inches.

An exceptionally warm period occurred, beginning January 21, *with a maximum of* 58° F. *and a minimum of* 35° *F*. A high point was reached upon January 28, with a maximum of 78° F. and a minimum of 52° F. The abnormally warm weather continued until February 2. For 8 days of the period, from

Table XXXVI

Monthly Maximum and Minimum Means of Temperature (Expressed in Degrees Fahrenheit) for the Experiment Station, Season 1916

1915 Nov.		1915 Dec.		1916 Jan.		1916 Feb.		1916 Mar.		1916 April	
Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
53.1	33.6	38.2	24	45.6	26.6	36.8	20.0	39.7	22.7	57.4	30.2

1916 May		1916 June		1916 July		1916 Aug.		1916 Sept.		1916 Oct.	
Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
72.2	50.9	74.1	55.3	82.6	65.6	84.7	62.4	77.4	53.0	66.3	43.6

January 21 to February 2, the minimum did not fall below 32° F. Following this period, the coldest weather of the year was experienced. The minimum decreased from 45° F. upon February 1 to 11° F. upon February 4, and the coldest day of the year was February 15, with a minimum of 4° below zero. Continued cold weather prevailed during March and delayed dormant season spraying. The minimum temperature was less than 32° F. for the first 25 days of the month, and even as late as March 18 the minimum was 6° F.

The highest temperature occurred upon August 21 and 22, with a maximum of 96° F. August 23 was only slightly cooler, with a maximum of 95° F.

The total rainfall for the year was 38.09 inches, or 10.63 inches below the normal, and yet there was no very severe drought at any time. The highest total rainfall for any one day occurred upon February 25, with a total of 2.00 inches. This is one of the lowest maximums ever recorded. During June precipitation was frequent, but small in amount, yet it

encouraged an exceptional vegetative growth of trees, grasses and weeds. In fact, precipitation occurred upon 15 days during the month, and it was very difficult for farmers to con-

Table XXXVII

Daily and Monthly Precipitation in Inches at the College Farm for the Year Ending October 31, 1916

	1915 Nov.	1915 Dec.	1916 Jan.	1916 Feb.	1916 Mar.	1916 April	1916 May	1916 June	1916 July	1916 Aug.	1916 Sept.	1916 Oct.	
1.				.25						.01			
2.		.06	.33	.71	.21								
3.				.58				.01	.53		T		
4.	.07				T	.03		.18					
5.	.03		.02				.38			T			
6.					.48	T			T		T		
7.					.39	.05	.14	1.33			.10		
8.		.05			.40	.67	.03	.39		T	.09		
9.	.10			T		.65	.24	.10			.08	T	
10.			.33		.05			.01	.63				
11.			.10	T				.27					
12.			.08	.07		.04				.25			
13.		1.10	.26	.40	T	.02		.03	T			.13	
14.	.08	.14				1.17	.03	.04	1.26			.11	
15.	.60				.40	T	T				1.23		
16.			.01		.14		.42	.06			.02	.01	
17.		.16	.07	.10		.07	.98	.18	.44				
18.		1.09		.01									
19.	.44				T			.35			.30	1.13	
20.	T*		T	.09	T		.03	.13	T				
21.				.02	.07			.08	.25				
22.			T		.63	.14			.80	T			
23.					T	.05	.48		.37	1.25	.01		
24.				T		.12				.07			
25.				2.00		T	T	.23	.25				
26.		.50	.06	.19		.44			.07				
27.	.15		T	T		.07			1.99	.69			
28.		.03		T	T	T	.42	T	.17	.34			
29.	.14	.77			.33		.02				.58		
30.			.18		.03						.03		
31.			.03										Totals
Total.	1.61	3.90	1.48	4.42	3.12	3.52	3.17	3.39	6.06	2.61	2.53	1.38	38.09
Normal.	3.30	3.74	3.28	3.61	4.08	3.45	3.72	3.33	6.42	5.75	3.93	4.11	48.72

* T—Trace.

trol weeds. Fruit trees in general made too much growth for the production of fruit of the highest color. As an exception, carnations planted in the field made a very slow growth. Reports of a poor development of plants were quite general. The carnation grows best where the movement of soil moisture is quite rapid. The amount of precipitation during August was exceptionally light, and yet crops were not affected to as serious an extent as in some former years.

Mr. L. G. Gillam, Mr. R. M. Hubbard and Mr. Paul Sassi have assisted in recording the weather observations during the past year.

REPORT OF THE DEPARTMENT OF ANIMAL HUSBANDRY

Department of Animal Husbandry

FREDERICK C. MINKLER, B.S.A., *Animal Husbandman.*

J. MARSHALL HUNTER, B.S., *Assistant Animal Husbandman.*

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Report of the Department of Animal Husbandry

Fredderick C. Minkler

I

INTRODUCTION

New Jersey farmers and stock raisers are awakening to the possibilities of meat production as a part of their farm operations. Advanced prices in meat and meat products, and the relatively small amount of labor necessary to the production of meat animals, together with the increasing population to feed, readily justified the movement for increased production and systematic methods of marketing. In order that the movement be successful, efficiency in production must be employed. Economy in feeding, improvement and selection in breeding, and a reasonable experienced judgment must be exercised in the care and management, if the margin of cost and selling prices are to be kept at a range. Because of these factors relating to the efficiency of gains, and because of the intensive type of farming generally employed by the New Jersey farmer, it is found that in a majority of cases the pig is chosen as the most efficient converter of raw feeding materials into food for human consumption. This interest is evidently State-wide, as evidenced by numerous inquiries from farmers at the leading county agricultural fairs and the Inter-State Fair held at Trenton, where educational exhibits from the Department of Animal Husbandry were staged, together with the hundreds of inquiries received by the department and by the farm demonstrators in the various counties throughout the State. Each had a slightly different problem, yet in a great majority of cases where the problem was adjusted to the conditions of that particular individual, it was found to resolve itself into one of the following phases of pork production:

1. Feeding for the market.
2. Discriminating between extravagance and economy in the ration for growing and fattening animals.

3. Utilization of by-products from the farm.
4. Housing and care of the animals.
5. Prevention and control of hog cholera.

To this end the department adjusted its investigations and feeding experiments, using the 15 acres of plots and yards and such equipment as is available for this work, and, in addition to this, maintaining a herd of 40 odd mature breeding animals for student judging and experimental work. The feeding trials listed in the contents of the report were outlined for the year 1915 and 1916 and have been under way since November, 1915.

II

FORAGE CROPS

Believing that it is necessary to produce on the farm the bulk of the feeding stuffs required for growing and fattening pigs, and holding that forage crops in various combinations serve this purpose most efficiently, the 15 acres available for investigational work at the Station were seeded with various combination mixtures of forage crops with the idea of determining their relative efficiency and economy as a source of succulence for such animals.

At the beginning of the spring season considerable difficulty was experienced in getting the crops seeded, owing in part to the unfavorable weather conditions, and further, to the fact that the bulk of the area had been pastured late in the fall and had been trampled considerably by the pigs, thus making it relatively hard to work over in the spring.

In order that some system might be arranged providing for the fertilization of the various areas, through the use of commercial fertilizers in addition to the voidings of the animals themselves, the following mixtures were applied:

Corn following Rye—

Acid Phosphate, ...	300 pounds	per acre.
Sulfate of Ammonia, ...	100 "	
Salt, ...	100 "	

Alfalfa—

Acid Phosphate.	300 pounds	per acre.
Salt, ...	100 "	

Forage Crops and Grasses—

Acid Phosphate, ...	200 pounds	per acre.
Salt, ...	100 "	

Mangels—

Acid Phosphate, ...	400 pounds	per acre.
Sulfate of Ammonia, ...	200 "	
Salt, ...	200 "	

Fig. 1.—Diagram of swine department of the New Jersey Agricultural Experiment Station.

The general plan of the area devoted to such investigational work is reproduced from last year's report, and the plantings that have been made during the past season are identified as follows:

Plot A.—One-half acre seeded with dwarf Essex rape on May 1 at the rate of 8 pounds per acre. This forage made very rapid and abundant growth during the early growing season and supplied succulence throughout the entire pasturing season. It was reserved exclusively for experimental purposes, as will be noted in the outlines that follow describing the yields and production of this area.

Plot B.—One-half acre, seeded on May 1 with a mixture of 12 pounds of dwarf Essex rape and 10 pounds of sweet clover. It was clearly evident that this amount of rape was extravagant, and it is believed that 6 pounds per acre of this seed in any mixture is sufficient to establish a satisfactory stand of plants.

Plot B was used to supply forage for two lots of Duroc-Jersey gilts used in the experiment to determine the relative economy of substituting black strap molasses for shelled corn. It was, therefore, divided into two equal areas of one-fourth acre each. On June 6, five Duroc-Jersey gilts were placed in each lot, those in area designated as A-1 weighed in at 779 pounds, and those placed in area identified as A-2 weighed in at 804 pounds.

It was determined by using tables in Henry's "Feeds and Feeding" that 14 pounds of shelled corn was equivalent in feeding value to 18 pounds of black strap molasses, and throughout our feeding experiments with these two products their value was figured on this basis.

It is interesting to note that these two areas of one-quarter acre each supplied green succulence for five brood sows averaging nearly 200 pounds apiece, which would mean, if established on an extensive scale, that one acre of rape and sweet clover forage properly supplemented with carbonaceous feeding stuff such as corn, molasses or hominy, would support 2 tons of live weight of animals.

Reviewing the past 3 years in our effort to determine the most efficient forage crop, it is believed that a combination of rape and sweet clover mixed in the proportion of 6 pounds of dwarf Essex rape to 18 pounds of sweet clover provides a mixture that should recommend itself to every farmer interested in economic pork production. It has the advantage of supplying

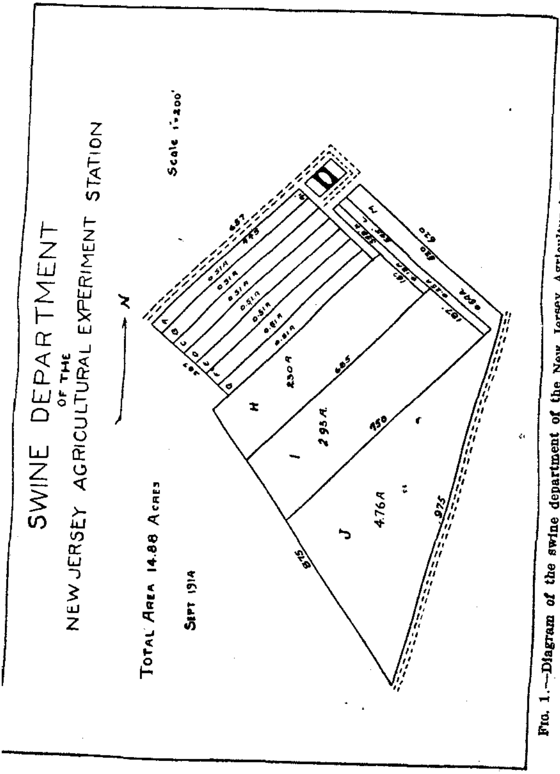

FIG. 1.—Diagram of the swine department of the New Jersey Agricultural Experiment Station.

both early and late forage, and the added quality of resisting unfavorable conditions and withstanding trampling during all seasons of the year.

Plot C.—One-half acre. Alfalfa was seeded in this plot in August, 1913. The area was pastured both early and late during the season of 1915. Consequently, it did not supply as much green forage as one might reasonably expect from an alfalfa field that was not pastured until it was 2 years old, and where precautions were taken not to turn the pigs into the area until the plants were 10 inches high in the spring, and to remove them not later than October 15 in order that the plants might obtain sufficient development to withstand weather conditions to the best advantage.

During the early season this area was used to furnish succulence to the ten gilts on Plots A-1 and A-2, and the records show that they pastured on the area from May 18 to June 6. Another group of animals was maintained on this same area together with the 10 brood sows, making a total of 3,200 pounds of live weight which foraged on this one-half acre area for nearly 30 days.

Plot D.—One-half acre. When the present area devoted to swine investigational work was set apart for this purpose, the 15 acres were seeded with alfalfa. Records show that three crops of hay were harvested during the seasons of 1909, 1910, and 1911, and that this area has been pastured continually with swine for five years. Naturally, the continuous pasturing reduced the number of live plants, especially in the front portions of the lots where the pigs had trampled over the area considerably. It was decided, therefore, to divide it into two equal areas identified as D-1 and D-2; D-1 being seeded with rape and soybeans on June 10, and D-2 used with a group of shoates in an experiment to determine the efficiency and economy of the free choice system.

Plot E.—One-half acre area. The same conditions prevailed in Plot E as have been described in Plot D. It served as a check in the feeding experiment relating to the use of the self-feeder.

Plot F.—On-half acre. A combination mixture that has been designated as the "Shot Gun Mixture," was seeded on this plot on April 20. The mixture is as follows:

Oats,	30 pounds	per acre.
Peas,	30 "	
Alsike Clover,	8 "	
Red Clover,	8 "	
Sweet Clover,	8 "	
Rape,	6 "	

It has been clearly demonstrated at the Station during the past year that this combination mixture has its distinct advantage. It is ready for pasturing early in the season and will supply an abundance of forage even after the first frosts check the growth of the plants.

Plot G.—One-half acre, seeded on April 20, to a mixture of ItoSan soybeans, 1 bushel, and dwarf Essex rape, 15 pounds. The addition of sweet clover to this mixture would add to its value as a forage crop for swine.

Plot H.—2.3 acres. During the late fall of 1915 this area was seeded with rye to be used as an early spring forage. By April 1 it was possible to turn in a number of brood sows with their litters on this area, and our

records show that before the end of the month 13 head of brood sows and their litters of nursing pigs had access to this plot. In addition to the green forage, they were fed corn, middlings and tankage supplied by means of the self-feeder. Probably because of this system of feeding they did not partake substantially of the green forage. The great disadvantage of rye is the fact that it grows so rapidly that it soon passes the stage when it is palatable for growing animals. As soon as it becomes woody the animals do not eat it with relish.

On June 13 this plot was plowed, prepared and planted with corn. It served as a test to determine the value of "hogging down corn," the details of which are given in the feeding experiment. Just previous to the last cultivation of the corn, soybeans and rye were sown broadcast in this field with the hope that they would supply some green forage and enable the pigs to have some protein-carrying forage with the corn. It was found that the area was shady, and the rape and soybeans did not gain a foothold.

Plot I.—2.9 acres. This was seeded on May 17 with the following forage crop mixture:

Oats,	30 pounds	per acre.
Peas,	30 "	
Soybeans,	30 "	
Rape,	6 "	

On June 27 this forage crop had gained the height of from 9 to 10 inches and 15 head of brood sows weighing 4,640 pounds were turned in. The animals for the most part were brood sows whose pigs had been weaned. They were turned out in order that their systems might be cooled and prepared for mating for September farrow.

The forage crop evidenced good vigor during the growing season and supplied the entire ration for these animals up to within a few weeks of their farrowing dates.

Plot J.—4.76 acres. This was seeded on June 27 with a mixture made up as follows:

Soybeans,	60 pounds	per acre.
Sweet Clover,	12 "	
Rape,	6 "	

It was pastured during the first week in August, at which time 7 mature brood sows were turned into this plot. As the season advanced the number was increased until 23 head of mature brood sows were foraging exclusively on this area. Early in September a group of 24 gilts were placed in the area, in addition to the brood sows. Later, the forage was supplemented with a grain mixture made up of hominy middlings and tankage. Early in October it was necessary to add some ear corn to the ration of the brood sows, but the amount given was less than one-half a pound of corn to 100 pounds of live weight per day. The animals finished the season in excellent condition.

Plot K.—One-half acre. This area was seeded on April 21 with the following mixture:

Oats, ...	30 pounds	per acre.
Peas, ...	60 "	

The forage on this area made excellent growth during June and July. A selected group of young gilts varying in number from 17 to 25, averaging 60 pounds each, foraged on this area during the entire season. The peas were especially paltable, a number of them podding and supplying concentrated feed for the growing pigs. About the middle of July the oats headed and reseeded themselves. On July 25 the reseeding of oats was supplemented by a mixture of rape and sweet clover. All of the animals were turned out of this area for 20 days in order that the forage crop might gain a foothold. It made most extraordinary growth and furnished succulence throughout the season with the exception of the 20 days utilized for the transition period.

Plot L.—One-fourth of an acre. It will be noted by referring to figure 1 on page 116 that Area L is an allayeway leading to Plot J. During the winter months three houses are grouped there and used for brood sows. Naturally, it is well fertilized, but mechanically it is abused by the trampling of the animals. It was seeded on May 21 with a mixture made up as follows:

Oats, ...	45 pounds	per acre.
Peas, ...	60 "	
Red Clover, ...	20 "	
Alsike Clover, ...	20 "	

The clover, especially, in this area was particularly palatable, the area being possibly too rich for the oats and peas as they lodged badly during the early part of the season. It was not used extensively but rather was kept for the brood sows at farrowing time.

Plot M.—0.18 acre. This area was likewise used as an alley leading to Plot I, and served the same purpose during the winter months as Plot L. Finding, however, that sweet clover had withstood the severe trampling which these plots received during the winter months, it was decided to replace oats with a mixture of sweet clover and dwarf Essex rape. No experimental data was gathered from this area other than the observation to determine a particular mixture that was hardy enough to withstand such abuse. It is clear that sweet clover outdistances all other forage crops in this particular. The habit of the plant, however, suggests that it should be permitted to seed itself once in 2 years, and furthermore, unless the plants are cropped down rather closely and severely during the beginning of the season, they are apt to become woody and not palatable for the young animals. The mature brood sows seem to relish the plant during all stages of its growth.

Plot N.—0.75 acre. This area has been seeded with mangel wurtzels for 4 years in succession, the mangels being used to supply succulence to the brood sows during the winter months. When alfalfa and ear corn are used as a basis for the ration for brood sows, it is believed that some succulence should be supplied. Nothing has been found to serve the purpose as efficiently as mangel wurtzels. True, the labor cost is considerable, but

it is believed that for such a supply of succulence during the winter months this expense is justified.

The mangels were seeded on June 8, were pitted during the first week of October, and yielded slightly more than 10 tons of mangels. Our experiments during the past year with forage crops justified the statement that they are necessary for the growing of swine for either breeding or marketing purposes. It is evident that the pen-fed pig is not a profitable unit unless he has been developed in the open range and given opportunity to develop a frame and engage an appetite that will enable him to gain rapidly. Combination mixtures have proven more useful than any single forage crop.

III

FEEDING EXPERIMENTS

Rations for Brood Sows

Name: A feeding experiment to test the value of molasses and ground alfalfa as compared with corn and alfalfa hay.

Purpose: To determine the feeding qualities of low-grade molasses or black strap.

Outline: In order to determine the feeding qualities of molasses and alfalfa hay, it was planned to work out a mixture of molasses and ground alfalfa hay, adding sufficient digester tankage to obtain the proper amounts of the various nutrients without providing a ration that would be too bulky for the digestive system of the hogs. It was planned that 1 lot of the animals be fed on a basic ration of corn and alfalfa hay, as a check against the molasses-fed lot. The 21 head of brood sows available for this purpose were divided into 3 lots. In dividing the animals, more emphasis was placed upon the balancing of the old and young sows, also on dividing the sows with attention to their past performance rather than attempting to obtain equal weights, in each of the lots. The breeds were also divided as evenly as possible. Table I shows the rations allowed the various lots, also the gains made by the animals.

Table I

Feeding Trial with Brood Sows

	1 Ear Corn Alfalfa Hay Mangels.	2 Ear Corn Tankage Alfalfa Hay Mangels.	3 Molasses Ground Alfalfa Tankage Mangels.
Number of animals.	7	7	7
Initial weight per lot, lbs.,	2598	2430	2660
Final weight per lot, lbs.,	2832	2620	2970
Total gain per lot, lbs.,	234	190	310
Average daily gain per sow, lbs.,	1.078	.875	1.43
Total feed consumed, corn, lbs.,	1302	1302	....
Total feed consumed, alfalfa hay, lbs.,	310	310	....
Total feed consumed, molasses, meal,*	....	....	1550
Total feed consumed, tankage, lbs.,	....	62	73.78
Total feed consumed, mangels, lbs.,	1080	1080	1080
Total cost of feed, lbs.,	$24.50	$26.05	$16.92
Cost per 100 pounds gain,	$10.47	$13.71	$5.45
Average daily cost of ration per sow,	$0.112	$0.120	$0.078

* Equal parts of ground alfalfa and black strap molasses.

Feed Prices: Ear corn, $1.00 per bu. of 70 lbs.; alfalfa hay, $20.00 per ton; tankage, $50.00 per ton 60% P; molasses, 10c. per gal. or $20.00 per ton; mangels, $5.00 per ton.

It will be noted from the above that the lot receiving molasses made the greatest gain and did so at a much lower cost of feed than either of the corn-fed lots. Lot 2, receiving tankage, failed to make as great a gain as Lot 1 where no tankage was given. This was due largely to the fact that the animals of Lot 2 were in a higher average condition at the beginning of the trial. It will be further noted that the molasses-fed lots consumed much more alfalfa than either of the corn-fed lots, averaging slightly more than 3 pounds per day as against slightly over a pound per animal in Lots 1 and 2. In connection with the above, it would be impossible to draw any definite conclusions from data covering so short a period of time. While the animals responded to the molasses mixture in a very encouraging manner, and while the gains on this mixture seemed to justify its practicability as a substitute for corn, yet it is possible from the brief knowledge of this mixture that the animals would tire of it if forced to subsist on a molasses and alfalfa ration for a continued period of time. It was not the intention of the department to draw any definite conclusions from this trial, as it was impossible to use the animals over a sufficient length of time to warrant the continued use of a molasses and alfalfa ration. The following observations were, however, noted:

1. After the sows were given a preliminary feeding period of 10 days they seemed to take to the molasses ration quite as well as the animals in any of the check plots to their respective rations.

2. The molasses did not seem to cause any digestive disturbances either in the way of constipation or laxative condition.

3. Voidings from the animals suggested that the excess of alfalfa hay which the molasses-fed animals consumed was quite as thoroughly digested as in case of the check plots.

4. The lot on the molasses ration consumed from 80 to 100 per cent more water daily than the other animals.

5. The hair and skin of the animals on the alfalfa and molasses ration evidenced a brighter and more glossy appearance than of the animals in either of the corn-fed lots.

6. Some little difficulty prevailed at the outset in getting the animals to clean up the entire amount of feed supplied, as there was a tendency to chew the ground alfalfa and molasses until the molasses had been extracted, and then to eject the alfalfa hay from the mouth. This was practically overcome within the 31 days during which the animals were actually on the trial.

7. No figures are available on the relative strength and vigor of the litters farrowed by the sows on these lots, but observations indicate that the pigs were just as strong, just as well developed, also that the milk flow of the dams was quite as pronounced in case of the alfalfa-and-molasses-fed lot as with either of the check plots.

Summary

The brood sows that were supplied with a ration of alfalfa hay, molasses and tankage not only made the most economical gains, but evidenced during the winter months a condition of

coat and quality of flesh that was clearly outstanding. It is believed that the addition of some hominy to this ration would have increased its palatability. It was demonstrated clearly that the grinding of alfalfa hay is the most efficient means of supplying this product to brood sows, as it not only increases their consumption of this feed, but also provides bulk and regulates the excretory system. It is possible to increase the amount of bulk by increasing the amount of alfalfa hay. Our aim was to get gains varying from three-quarters of a pound to one pound per day during the entire gestation period.

The records tabulated since this experiment was completed again emphasizes the importance that the brood sows be thin in flesh at mating time in order that they can be bred with greater ease and conceive with more regularity. Furthermore, it was demonstrated in this experiment that brood sows that gained steadily after being thin in flesh at the time of mating, farrowed pigs possessing more vigor than those in heavy flesh at the time of mating. It is a principle in pork production that must not be lost sight of, because brood sows that are heavy in flesh are not responsive to the mating instinct.

Rations for Breeding Gilts

Name: A feeding trial to determine the practicability of replacing corn with molasses.

Purpose: Because of the relative economy of low-grade or black strap molasses and because of its palatability when fed in connection with other grains, as a swine feed, the question of practicability as a feed for hogs becomes one of considerable importance, particularly in communities where home-grown feeds are not available. Since molasses is for the most part a carbohydrate carrier, it would seem possible that it might be substituted either wholly or in part for the corn in the ration.

Table II

Rations for Breeding Gilts

Corn vs. Molasses

	Lot I	Lot II
Number of pigs,	5	5
May 1 to Sept. 5, days on trial,	127	127
May 1, total initial weight, lbs.,	658	645
September 6, final weight, lbs.,	1180	1083
Total gain, lbs.,	522	438
Average daily gain per lot, lbs.,	4.11	3.45
Average daily gain per pig, lbs.,	0.822	0.69
Total feed consumed per 100 pounds, lbs.,	394.06	582.88
Feed cost per 100 pounds gain,	$5.586	$5.028

Note: The gilts were uniform in size, age and condition at the beginning of this trial.

Outline: A feeding trial was planned with 10 pure-bred Duroc-Jersey gilts, half of them being supplied with a ration of corn, tankage and alfalfa hay, the remaining half to receive the same proportion of food nutrients,

but supplied in the form of molasses and ground alfalfa, with the addition of limited amounts of digester tankage. These two lots were placed on trial April 18, 1916, and carried through until farrowing time, green pasture being substituted for the alfalfa hay during the summer season. Table II shows a summary of the gains made, also the amounts of feed required for each 100 pounds of gain.

It will be noted from the data that while the lot receiving corn, tankage and alfalfa, made slightly greater gains than the molasses-fed gilts, the uniformity in rate of gain is quite noticeable. The second table in connection with this feeding trial shows that while the corn-fed lot excelled in practically all measurements, in no case was there a striking weakness in any of the animals receiving molasses in place of corn.

Table III

Feeding Trial with Breeding Gilts

Corn vs. Molasses

Lot 1.	Corn, Tankage and Forage						
Ear tag number,	406	407	408	409	410	Total	Av.
Wt. of animals, lbs.,	216	225	252	242	260	1195	239
Heart girth, cm.,	109.2	123.2	120.6	114.3	121.9	589.2	117.8
Paunch girth, cm.,	132.7	134.6	130.8	134.6	137.1	669.8	133.9
Width of chest, cm.,	28.7	29.4	31.0	31.0	33.0	153.1	30.6
Width of chest, cm.,	28.7	29.4	31.0	31.0	33.0	153.1	30.6
Spring of ribs, cm.,	31.2	31.7	33.2	33.5	33.6	163.2	32.6
Depth of chest, cm.,	35.0	35.5	38.9	38.3	38.6	186.3	37.26
Cir. of fore cannon, cm.,	15.2	14.9	15.5	15.5	15.2	15.3	15.26
Cir. of rear cannon, cm.,	15.2	15.2	15.8	15.5	15.2	76.9	15.39

Lot 2.	Molasses, Tankage and Forage.						
Ear tag number,	401	402	403	404	405	Total	Av.
Wt. of animal, lbs.,	215	230	198	205	223	1071	214.2
Heart girth, cm.,	109.2	111.7	105.4	108.6	109.8	544.7	108.9
Paunch girth, cm.,	129.5	132.1	127.0	130.8	134.6	654.0	130.8
Width of chest, cm.,	30.4	29.5	27.4	28.4	27.0	142.7	28.54
Spring of ribs, cm.,	31.0	32.4	28.7	31.3	26.0	149.4	29.88
Depth of chest, cm.,	35.6	36.2	33.4	35.8	38.3	179.3	35.86
Cir of fore cannon, cm.,	14.6	15.5	14.9	14.9	14.9	74.8	14.96
Cir. of rear cannon, cm.,	15.2	15.8	14.9	15.2	14.9	76.0	15.2

Explanation of Measurements:

1. All measurements are reckoned in centimeters.
2. Heart girth and chest measurements were taken immediately back of shoulders.
3. Paunch girth was taken at greatest circumference between shoulders and hips.
4. Spring of ribs was taken over the last ribs 6 inches below the top line.
5. Circumference of cannons was taken at the smallest place between the knee and the pastern on the fore limb and at the smallest place between the hock and the pastern on the rear limb.

Table IV shows the record of each sow at farrowing time.

It will be here noted that the corn-fed lot was more successful in producing well-developed, thrifty pigs than the sows receiving molasses. With the exception of the one sow, ear tag 408, which proved farrow, the entire lot farrowed good, strong, well-developed pigs. While the lot receiving molasses was less successful at farrowing time, the litters of No. 402 and No. 404 would class as failures. It is not possible to say whether or not

Table IV

Farrowing Chart

Ear Tag.	Molasses, Tankage and Forage.					Corn, Tankage and Forage.				
	401	402	403*	404	405	406	407*	408	409	410
Farrowing date,	Oct. 7.	Oct. 30.	Oct. 6.	Oct. 30.	Sept. 7.	Oct. 23.	Oct. 18.	....	Oct. 19.	Oct. 18.
No. live pigs,	8	3	7	0	5	8	6	§	10	7
No. dead pigs,	0	6	0	6	0	0	0	§	0	0
Per cent. strong,	75	....	85.8	....	100	100	83.6	§	100	....
Milk flow of dam,	Good	Med.	Good	Little Milk	Fair to Good	Good	Good	§	Good	Good
Weight (in pounds) of pigs—										
No. 1,	2.9	1.9	1.9	‡	2.1	2.0	2.0	§	2.5	2.0
No. 2,	1.5	1.8	2.3	‡	2.1	2.1	1.9	§	2.0	1.9
No. 3,	2.5	1.5	2.1	‡	2.0	2.0	2.0	§	2.0	2.0
No. 4,	2.4	†	1.8	‡	2.1	2.4	2.3	§	2.8	1.8
No. 5,	1.6	†	1.5	‡	1.9	2.2	1.5	§	2.4	1.9
No. 6,	2.2	†	1.8	‡	....	2.0	1.7	§	2.8	2.1
No. 7,	2.5	†	1.8	‡	....	2.5	....	§	2.4	1.5
No. 8,	2.0	†	....	‡	....	2.2	....	§	2.6	....
No. 9,	....	†	....	‡	....	....	....	§	2.5	....
No. 10,	....	†	....	‡	....	....	....	§	1.9	....
Total,	17.60	5.2	13.20	....	10.2	17.40	11.40	....	23.9	15.2
Average,	2.20	1.73	1.885	....	2.04	2.17	1.00	....	2.39	1.88

* Pure Bred pigs.
- All other litters Poland and Duroc cross.
† The six were small and undeveloped. The three were weak.
‡ Only one of the six pigs was developed, the other five were premature and degenerated.
§ Was not pregnant.

the ration is entirely to blame for the abnormal condition of these two litters of pigs, as the other three sows in this lot farrowed normal litters and secreted a normal flow of milk. However, results indicate that molasses did not meet the requirements for the embryonic growth of litters as successfully as corn with the use of a forage supplement. Whether or not this condition is due to the lack of some nutrient in the molasses or to some toxic property, we are unable to state. It is hoped that further investigations will make this point clear.

The following observations were noted from time to time throughout the period of the experiment:

1. None of the gilts seemed to tire or grow stale on the rations supplied them.

2. All animals in both lots made apparently normal growth.

3. The molasses-fed pigs did not carry as much flesh as the check plot, yet they were practically equal in scale and frame.

4. The pigs on the molasses ration developed considerably more capacity in proportion to their other measurements than the corn-fed lot, which is perhaps accounted for from the fact that this lot took from two to two and one-half times as much water each day as the check plots. Further observations indicated that the molasses-fed pigs consumed considerably more forage than the corn-fed lot.

5. The lot receiving molasses evidenced a very laxative condition of the bowels throughout the period of experiment; however, this did not seem to weaken the animals or cause them to go off feed at any time.

6. The general thrift and condition of the two lots was quite similar, all animals being in apparently good health, although the lot receiving molasses presented a more or less smeared appearance about the heads and ears from the molasses adhering to the hair.

7. It was found that the gilts would take to the molasses more readily, and the mixture was much more easily handled when it was mixed with equal parts by weight with water. This mixture was poured in the trough and immediately cleaned up by the animals with apparent relish.

8. All animals settled with a single service except No. 408. She did not show evidence of recurrence of heat during the entire period.

Feeding Trials with Market Pigs on Forage Crops

Name: A feeding trial with market pigs on forage crops, with the use of the self-feeder or "free choice system" in comparison with the hand-feeding method as a means of supplying the grain supplement.

Purpose: There has arisen during the past year and a half considerable discussion as to the economy of the self-feeder as a means of supplying a grain mixture for market pigs on forage crops. The purpose of this experiment, then, was to determine, if possible, whether or not pigs will make as great gains with respect to rate and economy when permitted to choose the proportion of grain to supplement the forage crop as when the grain supply is limited to a 2 per cent ration (2 pounds of grain for each 100 pounds live weight) per day.

Outline: In order to obtain data on this problem it was necessary to maintain a considerable number of pigs on the same kind of forage crop, and at the same time to supply grain in a self-feeder to one lot and hand-feed the other lot, allowing but a limited amount of grain. Furthermore, to offset any difference which might occur due to the effect of a single kind of forage crop, it was planned to use four combinations of forage crops for both the self-fed and hand-fed lots. In this way, data were obtained on the relative merits of various forage crops.

Time Limit of Experiment: The time required to make definite determinations depends largely upon the response of the animals to their respective rations, also upon the weather conditions as affecting the growth of the various forage crops. Animals averaging 40 pounds at the outset should be carried until they reach a marketable weight of 200 or 225 pounds, which will ordinarily require from 160 to 190 days.

Details of Experiment: Forty-eight pigs were selected as a basis for an experiment to determine the relative efficiency of the two systems of feeding. They were divided into 8 lots of 6 animals each. Four plots of forage crops were provided on each of these areas and provision made whereby one lot was self-fed and one lot hand-fed in each plot. The following forage crops were available:

Lot 1—Dwarf Essex rape.

Lot 2—Alfalfa.

Lot 3—Oats, peas, rape, red clover and alsike clover.

Lot 4—Rape and soybeans.

On June 14, six of the lots, 2 of rape, 2 of alfalfa and 2 of the soybean mixture were deemed ready for the experiment. Owing to the fact that the season's conditions were not favorable for the growth in area No. 4, where it was intended to grow rape and soybeans, it was necessary to delay turning the animals into this plot for 2 weeks.

Table V presents the results of this trial, together with the mixtures and kind of grain fed.

It will be noted that while lots 4 and 8 did not make as much growth on rape and soybeans, it must be remembered that the experiment was run only 60 days and that the pigs in the other areas were on the forage 10 days longer than these lots, which is largely responsible for the difference. It will be noted from this table that while the self-fed lots made greater gains than the hand-fed lots, these gains were made at the expense of more feed per hundred pounds gain than those made by the hand-fed

lots. At this stage of the trial the record gives the impression that the self-fed pigs are the more costly. While data are not presented supporting the belief that the hand-fed pigs, when put on full feed at the end of the growing season, will greatly increase their cost of gains, yet observations and temporary figures taken from the experiment at the time this report is being assembled show that already the hand-fed pigs, when finishing on a full grain ration, are doing so at a greatly increased cost per hundred pounds, thus greatly raising the average cost of gain.

Table V

Feeding Trials with Market Pigs on Forage Crops

	I	II	III	IV	V	VI	VII	VIII
Number of pigs,	6	6	6	6	6	6	6	6
Days of trial,	70	70	70	60	70	70	70	60
Initial weights, lbs.,	276	275	282	313	271	268	292	307
Final weights, lbs.,	657	600	688	602	520	493	469	478
Total gain per lot, lbs.,	381	325	406	389	249	225	177	171
Average daily gain per pig, lbs.	.907	.774	.966	.804	.593	.536	.421	.47
Total grain consumed per lot, lbs.	1,330.5	1,181.3	1,310.1	1,153	506	505	505	439
Total feed per 100 lbs. gain, lbs.,	349.2	363.48	322.08	398.96	202.81	224.44	279.66	256.7
Feed cost per 100 lbs. gain,	$6.29	$6.54	$5.68	$7.02	$3.71	$4.10	$5.124	$4.6

Feeds and Forage

Lots I and V, rape, forage.
Lots II and VI, alfalfa, forage.
Lots III and VII, oats and peas, rape, alsike, red and sweet clover forage.
Lots IV and VIII, rape and soybean forage.
Lots I, II, III, IV, were self-fed on corn, wheat middlings, and tankage.
Lots V, VI, VII, VIII, were hand-fed on corn wheat middlings and tankage.

The following observations were made on the various forage crops during the growing season:

1. Rape forage in plots Nos. 1 and 5 made as abundant growth and withstood the summer pasturing slightly better than any of the other crops. It was found that the six hand-fed pigs on a quarter-acre of rape were scarcely able to keep the crop under way, while the six self-fed pigs were supplied with ample forage from one-eighth of an acre, through the months of August and

September. This lot was restricted to half of the original quarter-acre through August and September.

2. The alfalfa with only a medium stand proved to be a very successful forage and just keep the six hand-fed pigs without any cutting, while it was necessary to mow and remove a small amount of hay (approximately 250 pounds) from the quarter-acre, where the self-fed pigs were maintained.

3. The "shot-gun mixture" was very satisfactory with the possible exception that it made such an enormous growth during the early part of the summer that the oats and rape got ahead of the foraging animals, thus becoming rank, and the oats in the self-fed lot actually headed and ripened without much interference on the part of the animals. It would seem to indicate that in order to get the maximum results from any forage crop, and particularly from the "shot-gun mixture," that the number of animals foraging on any area should be regulated in such a way as to prevent the forage from getting ahead of the animals. During the early part of the season a great many animals may be used, as it will be found that under ordinary conditions at this season of the year the pigs are relatively small and consume proportionately very little forage, while during the latter part of the season the demands of the pigs increase rapidly, while the rate of growth may be somewhat impaired through the later summer months.

4. Lots 4 and 8 received their forage from a combination of rape and soybeans, and came nearer to keeping up with this forage allowance than any of the other lots. This may have been due in part to the condition of the ground at the time of seeding, also to the fact that soybeans do not seem to withstand continuous foraging during their early growth, as does rape or alfalfa. The portion of the rape and soybean plot where the hand-fed pigs were maintained proved to be the least efficient of any of the combinations of forage mixtures. During the latter part of August a change became necessary in order that this lot might have a sufficient supply of green feed.

Conclusions.—In regard to recommendations for forage crops to supplement the grain rations for market pigs, it is suggested that, while rape perhaps excels any other one forage crop from the standpoint of abundant growth and lasting qualities during the growing season, yet the fact remains that rape does not supply any of the advantages found in the leguminous crops, such as alfalfa, sweet clover, etc. It is believed that under similar conditions a good stand of alfalfa is quite as efficient and will produce approximately as much pork per unit of area as rape or

other combinations of forage crops tried out at this Station. At the same time it has the beneficial effect of nitrogen storing, and thus improving the soil. The fact that alfalfa is perennial may often give it the advantage. Rape and sweet clover in combination have many distinct advantages.

Feeding Trials with Market Pigs in Dry Lot

Name: Feeding trial for the purpose of determining relative value of peanut meal as a source of protein in the ration for fattening pigs.

Purpose: During the past year and a half, peanut meal has been underselling other concentrates, when the price is reckoned on its chemical analysis. For this reason it would seem possible that peanut meal might effect a considerable saving in the cost of gains, when used as a protein supplement to corn and wheat middlings in the ration for fattening pigs.

Outline: In order to obtain data upon the cost of gains made by pigs consuming peanut meal as a source of protein, it was necessary to maintain a check lot of pigs of the age, type and breeding of those receiving peanut meal. The check lot received their protein-rich supplement from digester tankage. The two lots of pigs were fed in dry lot allowing one lot a full feed of corn, wheat, middlings, and tankage, in separate compartments of the self-feeder, and acting as a check against the second lot receiving corn, wheat middlings, and peanut meal, under similar conditions. Thus the free choice system was employed, permitting the pigs within each lot to make their own choice in regard to the proportions of and total amount of feed consumed.

Time limit of the trial: Time over which this trial should extend will depend largely upon the response made by the animals to the different rations, and also the effect upon the general health and thrift of the animals. Sufficient time should be allowed in order that any ill effects may be determined, and until each of the different rations has a chance to prove its merit.

Details of this trial: The dry lot method of feeding was pursued in two lots of 5 animals each; fresh water and salt were kept before the animals at all times. The feeds were weighed back and the weights of the animals recorded at intervals of 10 days. A preliminary period of 10 days was granted in order that they might become accustomed to their respective rations and the manner in which they are supplied. Simultaneous with the above trial, a third lot was tested similar to the first and second, and received a ration of hominy feed, wheat middlings and tankage in a self-feeder. The object of this trial was to determine the relative value of hominy feed as a source of carbohydrates, checking its merits with those of corn in lot No. 1. A summary of the results is shown in Table VI.

According to this table it would seem that the lot receiving corn, middlings, and tankage, made the greatest gains in the time allowed, and consequently the cost per pound of gain was less than that of either lot No. 2 or No. 3. It is further interest-

ing to note from the above table that these pigs did not consume as much feed a head per day as those in lot No. 2, and only slightly more than those in lot No. 3, yet the average total gain per head was greatest for this lot. Lot No. 2 consumed considerably more middlings in proportion to the total feed than either of the other lots, a fact which would support the belief that peanut meal, though consumed in as large a quantity as tankage, did not supply their wants as thoroughly as digester tankage.

Table VI

Feeding Trials with Market Pigs in Dry Lot

	Lot 1	Lot 2	Lot 3
	Corn Middlings Tankage	Corn Middlings Peanut Meal	Hominy Meal Middlings Tankage
Number of pigs in lot,	5	5	5
Number of days fed,	39	39	39
Initial weight per pig, lbs.,	37.2	37.0	36.8
Final weight per pig, lbs.,	65.4	62.2	47.6
Total gain per pig, lbs.,	28.2	25.2	10.8
Average daily gain per pig, lbs.,	0.723	0.646	0.276
Average feed consumed daily per pig, lbs.,	1.864	2.163	1.678
Feed per 100 pounds gain, lbs.,	257.80	334.83	607.97
Cost of feed per 100 pounds gain, @ 1.6c per lb.,	$4.12	$5.36	$9.73
Per cent corn or hominy eaten,	68.08	52.84	65.75
Per cent middlings eaten,	26.40	40.70	31.50
Per cent tankage or peanut meal,	5.50	6.46	2.74

Observations and conclusions: For the short period of time over which this trial was conducted, and with the limited amount of data collected, it was not the purpose to draw conclusive opinions regarding peanut meal as a source of protein to supplement corn and wheat middlings. While none of the pigs experi-

enced any noticeable ill effects from this ration of peanut meal, with corn and middlings, yet observations from time to time seem to indicate that the animals would tire of this and would perhaps choose tankage in preference to peanut meal if given free access to both. Hominy feed, from a standpoint of chemical analysis, is practically the same as corn, yet the pigs failed to respond in gains when receiving hominy feed, as did the lot on corn. The figures on the gains made and costs per pound of gain are scarcely fair to lot No. 2, as one of the animals showed a decided lack of thrift throughout the greater part of the trial and later was found to be badly infected with worms; also one other animal from this lot appeared not to make gains at the same rate as the remaining three animals in that lot. It is not likely that these abnormal conditions of the animal were due to the ration supplied them, but were somewhat affected previous to the outset of the trial. It is the plan of the department to conduct further trials with both peanut meal and hominy feed as supplementing the ration for market pigs.

Feeding Trials in Hogging Down Corn

Plot H, 2.3 acres, was planted to corn in the early part of June in order that some of the experimental pigs might be finished to a 200-pound weight by full-feeding on this area in September and October. Soybeans were sown broadcast during the midsummer in order that a liberal undergrowth of green feed might be available at the time the pigs were to harvest the crop. However, because of an outbreak of cholera in two of the experimental lots which were to have been used in the hogging down trial, it was necessary to supplement the remaining few head with other stock from the herd. Thus it was impossible to secure data from which any definite conclusions could be drawn. On September 22, thirteen head of pigs were weighed and turned into the cornfield. From time to time other pigs were added, including 6 head of mature sows to aid the young stock in breaking over the stalks of corn. On October 12, the entire lot numbering 26 head were weighed, and showed an average daily gain of 1.465 pounds per animal. This includes 6 sows averaging about 375 pounds each, and 20 head of shoates averaging scarcely 75 pounds. During the time the animals were harvesting the corn crop, no feed was allowed in addition to that furnished by the cornfield save digester tankage, which was before the animals at all times in the self-feeder.

The following observations and conclusions may be noted as a result of the experiment:

1. The pigs experienced no difficulty in becoming adapted to their ration of new corn, after being shifted to this ration gradually by cutting small amounts and carrying it to the animals daily before turning them into the field.

2. The pigs cleaned up the field with practically no waste whatever.

Owing to the favorable weather conditions through the months of September and October, the waste from this method of feeding was kept at a minimum.

3. No permanent injury was done to the soil by allowing the pigs to harvest the corn as sometimes occurs when pigs are permitted to run at large over an area during a wet season. (This area was plowed and seeded to winter rye on October 29, when little difficulty was experienced in preparing a seed bed.)

4. Hogging down corn has several advantages over other methods of feeding market pigs, namely: (a) A minimum amount of labor is necessary; (b) animals balance their own rations in a very efficient manner when tankage is supplied; (c) the crop is harvested without cost to the farmer; (d) all manure is returned to the soil without expense of hauling; (e) gains are made as rapidly and as economically as when the animals are fed by hand; (f) pigs root out and destroy many weeds. It is further suggested that where pigs are to be used for hogging down corn that they be carried through the summer on a limited grain ration, supplemented by an abundance of forage crop, as such pigs are better rustlers and more efficient in harvesting the corn crop than pigs which are in high condition at the time they are turned into the field. This method of finishing pigs may also have the advantage of utilizing a larger percentage of the concentrate ration at a period of the year when corn becomes cheaper in price, thus the farmer is not forced to feed extremely costly purchased feeds through the summer months in case his corn supply is limited.

IV

HOG CHOLERA

With the reorganization of the Department of Agriculture in July the control work relating to animal disease was conducted under the direction of this body. A regular inspector was added to the force, and a campaign of education launched, that it is believed will bring about the desired results.

In our report for 1915 we discussed the outbreak of hog cholera that devastated the herd in September of last year, and finally resulted in subjecting the entire herd to the serum simultaneous method of treatment with the hope that it would establish permanent immunity in the breeding herd. It is true that all of the animals that were subjected to the serum simultaneous

treatment at that time survived, and no losses have been incurred in the original breeding herd. However, we have not been successful in perpetuating the immunity in the young animals, and at several intervals during the past year we have been compelled to resist an outbreak of the disease. Unfortunately, the claim that has been repeatedly put forth that suckling pigs farrowed by immune sows are immune at least during the nursing period has not been substantiated at this Station. We have experienced an outbreak among our suckling pigs, the cause of which cannot be clearly traced.

It was deemed advisable to continue the serum simultaneous treatment in our herd, since its location is almost contiguous to the serum plant operated by E. R. Squibb & Sons, where a large number of virus, as well as serum, hogs are assembled for serum manufacturing purposes. Furthermore, the experimental work conducted in connection with the swine department has attracted considerable attention among those interested in pork production, and it is next to impossible to isolate the herd from the visitation of farmers whose herds may be infected with cholera, and who may visit the herd for advice and information concerning methods of control and eradication. Not only this, but the Station had made a policy of loaning its breeding boars within certain districts in the State to promote interest in swine production, and it was feared that return shipments might bring infection in case the herd was not permanently immune.

It has been justly claimed by those who are opposed to the serum simultaneous treatment that the premises becoming once infected it is scarcely possible to disinfect the areas thoroughly enough to rid the premises of infection. On the other hand, there is a fixed charge incident to the serum simultaneous treatment that the swine industry can scarcely be carried at present prices, and if the treatment stunts the pigs, as it is claimed, it is doubtful whether the practice should be encouraged for general adoption.

On July 15 two litters of pigs were simultaneously treated. One litter had been weaned approximately two weeks, while the other litter had just been removed from the dam. It has been pointed out that suckling pigs do not maintain their immunity if the serum simultaneous treatment is administered before they are weaned and placed on solid food. A total of 16 pigs from these two litters were treated as above noted. The litter nursing was made up of 9 pigs, and within 6 weeks 5 of these animals were classified as runts. They evidenced no loss of appetite apparently as a direct result of inoculation, but normal growth and regular development came to a standstill from the very

moment they were treated with serum and virus, until they were finally killed for autopsy. The veterinarian who posted the pigs stated emphatically that they were free from symptoms of hog cholera, but that they evidenced an anæmic condition, and their digestive system clearly indicated that their own vitality had been lessened in their endeavor to resist or throw off the attack of hog cholera. The mothers of both litters during this period were normal, and healthy.

Another type of complication experienced at the Station during the past season occurred early in September, when two animals in Plot 7 evidenced characteristic symptoms of hog cholera. They had previously been subjected to the serum simultaneous treatment when weighing 60 pounds, and it seemed rather unusual to have an outbreak occur 60 days from this date. The two animals were isolated at once. One was given an injection of 60 cubic centimeters of serum, while the other was killed and posted. Upon a post-morten examination it was found that this animal evidenced typical symptoms of chronic cholera; lesions were present in the lungs, button-shaped ulcers were found in the intestines, the kidneys were speckled, in fact every evidence that would identify cholera was recorded.

On September 10 three more pigs evidenced the preliminary symptoms of cholera; one showing spasms accompanied by diarrhea and the characteristic purple spots. They were immediately isolated from the herd, and it is interesting to note from table VII the conditions finally developing from this outbreak.

From the table it will be noted that while all of the animals were given the double treatment, and at the instance of the outbreak were given a double dose of serum as a protection, the results were nil when the pigs evidenced any temperature at the time of injection.

It is interesting to note that two animals in Plot 3 that were treated with 20 c. c. of serum on September 20, at which time they were perfectly normal with respect to temperature, appetite and action, developed characteristic symptoms of hog cholera on the sixteenth. On the eighteenth one of the animals was treated with 20 c. c. of serum and died on the twenty-first. The second pig in the same lot was treated with 60 c. c. of serum on the nineteenth, at which time the animal had a temperature of 108° F., but evidenced no other symptoms. On October 1 this pig died after being off feed for 2 days. Thus the outcome of these records supports the claim that 90 c. c. of serum, one-third of which is administered before any indication of the disease is in evidence, will scarcely protect an animal exposed to the dis-

ease even though a reasonable amount of serum may be injected under normal conditions of temperature. Just how long these particular animals had been resisting or resistant to the disease is not known.

Concerning the cause of these and subsequent outbreaks of hog cholera at the Station herd, in instances where the animals had been previously subjected to the serum simultaneous treatment,

Table VII

Summary of Hog Cholera Outbreak

Ear Tag	Temperature, Degrees F.	Dosage	Remarks
September 9, 1916			
237	104.8	30 c.c.	
238	107.4	30 c.c.	Died Sept. 10, 1916.
239	108.0	30 c.c.	Died Sept. 15, 1916.
242	106.8	30 c.c.	Died Sept. 12, 1916.
241		60 c.c.	Died Sept. 13, 1916.
240	108.0	60 c.c.	Died Sept. 9, 1916.
September 11, 1916.			
243	106.6	60 c.c.	Died Sept. 19, 1916.
245	103.3	30 c.c.	Died Sept. 26, 1916.
244	103.2	25 c.c.	
246	108.1	50 c.c.	Died Sept. 15, 1916.
247	102.3	25 c.c.	
249	103.0	25 c.c.	
September 13, 1916			
224	104.0	20 c.c.	Died Oct. 1, 1916.
223		20 c.c.	
220		20 c.c.	
221	103.5	20 c.c.	Died Sept. 21, 1916.
219		20 c.c.	
222		20 c.c.	

only one answer seems reasonable. This suggests that they were not given a sufficient amount of virus at the time the double treatment was administered. Surely no other explanation seems as reasonable. The serum was certainly potent and protected the animals, the virus was virulent since the check animals died, and 90 per cent of the herd survived, having received the treatment in regular form. This leads to the suggestion that the small dosages of virus that have been used in the permanent protection work are insufficient to establish definite protection. The theory was advanced and supported quite generally two years

ago that ideal conditions for treatment were brought about by subjecting the pigs to a serum alone treatment at the outset; this to be followed in 10 days by the serum and virus injection. We are led to believe from the results obtained by this practice not only in the Station herd, but in several herds in various parts of the State, that even this practice is seriously at fault. It is doubtful, indeed, whether or not the virus is actually effective when administered into a pig that has been given a previous dose of serum. Sufficient anti-bodies are present to resist any action of the virus, and permanent immunity is not obtained.

It would seem that, if it is desired to establish permanent immunity in a herd where the serum simultaneous method is involved, it is absolutely necessary to keep the young suckling pigs free from external infection previous to the serum simultaneous treatment; and, further, that this double treatment should not be instituted until after the pigs weigh at least 50 or 60 pounds, if it is desired that it shall be permanent and perpetual. Herein lies the danger of the practice, for it would be difficult, indeed, to maintain premises free from cholera infection during this time, especially since there may be carriers in the herd as a result of their previous double treatment.

One other suggestion is made and supported by the season's experience, that is, if it becomes necessary to subject nursing pigs to the double treatment before they have reached the weaning age, the treatment should be repeated in 6 or 8 weeks, if it is desired to establish permanent immunity. Again, we have some evidence to support the claim that an arrangement providing for a second or third, or even an annual, inoculation by means of the double treatment is necessary under certain conditions to establish permanent immunity or protection.

The most serious problem confronting the swine producer who has adopted the double treatment is a definite answer to the question as to whether it stunts the pigs and prevents normal growth and development. We have evidence at this Station that supports the claim beyond question, for we have not been able to maintain more than 25 per cent of the animals at the growth and development that characterized the herd previous to the adoption of this method of protection. A certain percentage of the animals, however, gained normally, but at least 75 per cent of them were set back, and in many instances possibly 20 per cent of the animals were permanently dwarfed. A pig without an engaging appetite is certainly out of place on any farm, for we must develop that constitutional vigor and vitality so marked among swine if we are to obtain a new dollar for an old one in our feeding operations.

REPORT OF THE DEPARTMENT OF POULTRY HUSBANDRY

Department of Poultry Husbandry

HARRY R. LEWIS, B.SC., M.AGR., *Poultry Husbandman.*
WILLARD C. THOMPSON, B.SC., *Assistant in Poultry Research.*
* ROY F. IRVIN, B.SC., *Specialist in Incubation Studies.*
MORRIS SIEGEL, *Poultry Foreman.*
ELMER H. WENE, *Superintendent, Vineland Contest.*

* Appointed November 1, 1916.

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Report of the Department of Poultry Husbandry

HARRY R. LEWIS

WILLARD C. THOMPSON

I

INTRODUCTION

The various lines of activities carried on by the Poultry Department during the year 1915–1916 have progressed satisfactorily. The new poultry farm, which is to be used exclusively for research and commercial purposes, is now approaching completion and bids fair to exceed, in size and efficiency, anything of its kind at present in existence in the equipment of state agricultural colleges.

The research and experimental problems have been carried on, as previously outlined, and many short laboratory tests have been conducted. The extension activities have multiplied rapidly, and the demand upon members of the Station staff for outside work has become a considerable burden. It is impossible for the extension specialist alone to handle the great volume of requests coming to the department for such services.

During the current year the Vineland Three-Year International Egg Laying and Breeding Contest has been promoted and successfully started. This line of work is new in New Jersey, and it will take a considerable part of the time and attention of the department members; yet the great volume of data which can be secured from such a study, and the extensive publicity secured, will warrant such efforts.

The poultry husbandman wishes to express at this time his appreciation to all members of the poultry staff for their assistance and coöperation in promoting the work during the past year. Numerous changes have been made in the staff, due in part to the reorganization made necessary by the Vineland International Egg Laying and Breeding Contest. Mr. Roy F. Irvin, formerly holding the position of instructor in poultry husbandry at Rutgers College, has been placed part time on research activities and will conduct far-reaching research observations on problems pertaining to incubation and brooding. Mr. Elmer H. Wene, formerly superintendent of the Station poultry

plant, has been transferred to the Vineland Contest as superintendent. Associated with him in the work of conducting the contest are Messrs. James G. Rugh, George M. Dunn and Albert Bertolla. Numerous temporary assistants and helpers have been secured during the year as the work required. During last winter the services of Mr. Horace V. Cory, a graduate of Rutgers College, at present in charge of the poultry department at Delaware State College, were secured to carry on certain statistical observations pertaining to some of the problems under investigation. Mr. Clarence Morey and Mr. Herbert C. Segur, senior students in the Poultry Department, coöperated with the Station staff in compiling data and making observations on quality in meat scrap and on variations in commercial poultry rations.

At present the Station and contest staff are made up as follows:

Harry R. Lewis, Poultry Husbandman.
Willard C. Thompson, Assistant in Research.
Victor G. Aubry, Extension Specialist.
Roy F. Irvin, Special Incubation Studies.
Morris Siegel, Foreman.
William Pape, Assistant.
Edward H. Stokes, Assistant.
Antal Kiss, Assistant.
Mary B. Reed, Stenographer.
Kathryn L. Reed, Stenographer.

Vineland International Egg Laying and Breeding Contest

Harry R. Lewis, Supervisor.
Elmer H. Wene, Superintendent.
James G. Rugh, Foreman.
George M. Dunn, Assistant.
Albert Bertolla, Assistant.
Faith R. Lewis, Clerk.

Weekly departmental staff meetings have been held every Friday morning from 11 to 12 o'clock. These meetings have resulted in a more complete organization of the work and greater interest and coöperation on the part of staff assistants.

Future Plans

During the coming year it is anticipated that no great changes or new developments in the work will take place. It will be rather a period of consolidation, the completing of activities and new construction already under way. Every effort will be made to collect all possible data in connection with the Vineland Con-

test, which, together with the research observations in progress at New Brunswick, should be productive of many far-reaching conclusions.

NEED FOR NEW BUILDINGS.—The one big need of the Poultry Department at the present time is for a large building which will adequately house the department. The present poultry husbandry building is not large enough to accommodate satisfactorily the research activities of the department. No facilities of a satisfactory nature are available for educational work. Appreciating this need, the organized poultry interests in the State of New Jersey have already started a campaign which will run throughout the ensuing year, the aim being to raise by subscription and pledges a sufficient amount of money to construct the center section of the group of buildings which was described in the 1914 annual report.

Financial Statement

The following is a financial statement covering the cash and credit sales of the department from the year November 1, 1915, to October 31, 1916, it being expected that during the ensuing year, with increased stock and housing capacity, the revenue of the department will be somewhat increased:

November, 1915, $132.42; December, 1915, $129.23; January, 1916, $301.21; February, $500.28; March, $567.19; April, $393.70; May, $518.50; June, $498.63; July, $411.84; August, $580.41; September, $297.68; October, $149.56; total, $4,480.65.

No effort is made in this statement to give a complete inventory, but the number of birds on the plant has materially increased during the past year, which, if a true financial balance is shown, would result in considerably greater financial returns than is shown by the cash and credit sales only.

Plan of Report

A detailed report of the Poultry Department will be presented under three heads, namely: 1. Research; 2. Practical Application of Investigational Work; 3. Vineland International Egg Laying and Breeding Contest.

Owing to limited space in the report and length of time required for publication, it will not be the practice to describe the research problems in any great detail, but simply to give a report of progress, and, where desirable, to cite certain conclusions which have been sufficiently proven to warrant their acceptance as facts.

II

RESEARCH

In discussing the research activities of the department in this report, it has been deemed wise to group the various studies according to the nature of the problem, *e. g.*, breeding problems, incubation problems, marketing problems, etc. Some of the problems cited below have been under progressive study for a number of years, while others have been started during the past year, and still others are being started at this writing. Some are simply laboratory tests of short duration, while others are extensive projects covering a period of years. In each instance the duration and nature of the study will be given together with a short outline.

Breeding Problems

1. INHERITANCE OF COLOR PIGMENT.—The color pigment problem is one which this department has been studying for a number of years, both in pure-bred as well as in cross-bred generations. In general, it might be said that the aim of the problem is to get accurate data pertaining to the mode of inheritance of color pigment, as shown in plumage, in shank, in eye, in skin, and in egg-shell color. Incidentally, in connection with this study, observations have been made pertaining to the mode of inheritance of shank feathering and comb character. In the past all cross-bred studies have been made with Black Langshans and White Leghorns. During the past spring reciprocal matings of Barred Plymouth Rocks and White Leghorns, and Black Hamburgs and White Leghorns were made, the idea being to check the work with Black Langshans and to get more definite data on the barring factor. F-1 matings from these reciprocal crosses are being made this winter and the progress of the work will be reported from time to time. In connection with this work the presence or absence of an inhibiting factor for pigmentation and barring is being observed in cockerels representing 14 different and supposedly unrelated strains of Single Comb White Leghorns, the cockerels for this work being secured from the strain test project discussed later in this report. The department is coöperating with the Rhode Island Agricultural Experiment Station, through Dr. P. B. Hadley, by supplying duplicate cockerels which he is to test out in order to check our results.

2. EGG-SHELL COLOR.—The general trend of investigation along poultry lines at present is more or less determined by the value which the results of such work would have to practical poultry keeping. This is, perhaps, especially true because of the comparatively recent date at which experimental work along this line has been undertaken. One of the great problems which has

confronted the commercial poultryman, and in fact every poultry raiser who sells his products to the market, is that of the shell color of eggs. The more discriminating markets of today pay premiums for sorted and selected eggs. One of the chief points in the classification of market eggs in many instances is the uniformity in shell color. Some markets prefer a white-shelled egg, and others a brown-shelled egg, but all demand a fairly high degree of uniformity in that color of either white or brown. Particularly in the case of brown-shelled eggs has there been noticed a marked variation in the shade of brown. This has, to some extent, undoubtedly been determined by the breed, but probably influenced more by other factors which have not been definitely recognized. In order to find out what these other factors might be and to ascertain the relative importance of each, a special series of investigations was started in this department last year.

The first step in the study of this problem was to gather data as to the amount, nature, and extent of variation in shell color of eggs produced by several representative birds of several different varieties and breeds. Approximately 135 Barred Plymouth Rock pullets were used in this observation work, along with which approximately 120 Single Comb White Leghorn pullets, 25 Rhode Island Red pullets, and 24 Light Brahma pullets were studied. In other words, the investigation covered 4 breeds, one of the Mediterranean, or so-called egg type, two of our well-known American type, and one of the Asiatic class. These breeds were selected partly because of their recognized popularity and widespread adoption, and partly because the equipment and stock were at hand with which to make this study.

The following objects were borne in mind in conducting this first year's work:

1. A standard egg-shell color must be made with which all eggs produced by birds included in the observation may be compared; each color to be named and numbered in order to allow of accurate and efficient record.

2. The shell color of eggs produced by trap-nested individual females must be recorded each day and charted in the order in which the eggs were laid, accurate records being kept of the exact number of the color.

3. Comparison of the shade of shell color of eggs produced by representative birds of different breeds must be carefully made. This was considered essential in order to determine whether or not the shade of color exhibited in the egg-shells was a breed characteristic, or more an individual characteristic.

4. The individual females must be classified after the completion of the first season of egg production, according to the type and manner of variation exhibited in their eggs.

The following table indicates the kind and number of individuals whose egg records were carefully studied during the year:

Breed.	Color of Shell.	No. of Birds.
S. C. W. L.,	White	120
B. P. R.,	Brown	135
R. I. R.,	Brown	25
L. B.,	Brown	24

A standard was prepared by selecting eggs of varying shades of color, ranging from a pure chalk white to a very dark brown, making this selection from several hundred eggs produced by the various breeds used in the test. This selection was continued until the standard apparently contained representatives of each shade of color that was liable to be found during the year. It finally included 23 colors, which are listed below, arranged in order of color sequence, in so far as is possible to do so:

1. Pure chalk white. 2. Faintly tinted, toward ivory. 3. Faintly tinted with pink. 4. Light ivory yellow. 5. A shade lighter than cartridge buff. 6. Cartridge buff, with slight spotted effect in texture of shell, but with no foreign color. 7. Light pinkish cinnamon, but with spotted effect in texture of shell, having no foreign color, however. 8. Light pinkish cinnamon. 9. Cartridge buff. 10. Omitted. 11. Light ochraceous-buff. 12. Pale ochraceous-salmon. 13. Light pinkish cinnamon with sizable spots of chalk white, varying greatly in size. 14. Light pinkish cinnamon with sizable spots of chestnut brown. 15. Ivory yellow with few pepper-like spots of Rood's brown. 16. Vinaceous-buff with good-sized spots of wood brown. 17. Vinaceous-buff with heavy sprinkling of chalk white fine spots. 18. Light vinaceous-cinnamon. 19. Tilleul-buff. 20. Cartridge-buff, a shade lighter. 21. Light vinaceous-cinnamon with many fine spots of walnut brown (pepper-like spots). 22. Pale vinaceous-fawn with very small white spots. 23. Vinaceous-buff.

This description of colors is founded on the color charts made by Mr. Robert Ridgway in his "Color Standards and Nomenclature."

After a careful study of the variation as shown in this first year's record, the following conclusions would seem to be justified. It is to be understood that this work is a preliminary investigation, simply the result of the first year's observation, but considered to be of value because of the large number of individuals used in obtaining the data.

1. To a certain extent the shade of egg-shell color may be considered as a breed characteristic. A most striking example of this was found in the case of eggs produced by the Light

Brahmas. In approximately 80 per cent of the Light Brahma eggs a decided reddish-blue tint was noted. This peculiar shade of color was found only in scattering instances in the eggs of either the Barred Plymouth Rocks or the Rhode Island Reds. Apparently this peculiar shading is, at least partially, a characteristic of the Brahma breed. No striking difference was noticed between the eggs of the Rhode Island Red breed and the Barred Plymouth Rock breed. In most cases it would have been practically impossible to sort out the eggs of one breed from those of the other, if they had not been marked.

2. One of the most surprising results shown in this work was that at least 50 per cent of the birds showed a very marked variation from day to day. In most of the pens the individuals that laid eggs of uniform color day after day were the exception rather than the general rule. This observation is of considerable interest in view of the fact that many poultrymen have in the past considered that it was possible to identify the eggs of trap-nested individuals after having become familiar with the general shade of color usually produced. It would have been quite impossible to do this with any degree of accuracy in the cases of birds used in this work. It is true that in the cases of certain individuals a peculiarity in shell color would allow of this identification.

3. Sufficient difference in this variation was noted to warrant further investigation and question as to its causes and control. Particularly will the problem of its inheritance from one generation to another be studied. From the fact that in pens all fed alike and cared for in a similar manner there occurred birds that were uniform in regard to the color of eggs produced, as well as birds that varied widely from day to day, it was considered that probably this factor is not affected by feeding and environment, but is rather a question of breeding.

4. Definite matings have been established as a result of this first year's observations. The trap-nesting of all birds will be continued, and all eggs in the breeding season will be pedigree-hatched.

5. Because of the time required to grow, develop and test a generation of fowls, the results of this experiment will not become definite and conclusive for several years.

3. Inheritance of Fecundity.—Considerable progress is being made in the problem relating to the study of inheritance of fecundity in White Leghorns through careful mating and continuous selection. A limited family of the White Leghorn

variety has been developed, the members of which are remarkably consistent producers, a certain section of this family having produced during the past year over 200 eggs each in 10 months, beginning in November and ending in August. This fecundity work is being carried on under two definite lines: A, to mate females of known production to males of unknown production and then to study the resulting lay made by all progeny from these matings; B, to mate birds of F-1 and F-2 generations in order to determine, if possible, the relative importance of father and mother in regard to transmitting the fecundity factor to their individual sons and daughters. Trap-nesting, pedigree-hatching, and pedigree-breeding have been followed continuously in this work. A similar work with Barred Plymouth Rocks has been inaugurated during the past year.

A practical result of the study of this problem will be to produce in considerable number cockerels carrying factors for high fecundity which can be distributed about the State for the improvement of the general flocks. The distribution of these cockerels has been limited in the past, owing to the lack of facilities to grow a sufficient number. It is hoped that this will be corrected by the addition of increased range areas on the new poultry farm. The work of inheritance of egg production will be continued as one of the main problems of this department.

4. A Study of Variation in Strains of Single Comb White Leghorns.—This strain, or family study, was started in the spring of 1916 and had for its object a study of the normal variation in different strains of the variety Single Comb White Leghorn. Such factors as fertility, hatchability, growth, size, fecundity, etc., were studied. Seventy-five hatching eggs were secured from each of 14 different commercial farms in the United States. In this study these farms will be designated by numbers from 1 to 14. The eggs were received during the month of April and all possible observations kept as to the condition of the package, kind of package, shipping costs, etc. The eggs were uniformly hatched and brooded. A uniform number of pullets from each flock, the best in each lot, have been selected and placed in laying houses, and are to be trap-nested throughout the ensuing year. Some of the best cockerels from each flock have been retained to be used for breeding in order to give as complete a record as possible concerning these strain variations. The complete results of this study will be published in the form of a bulletin, after observations covering a period of years have been made and actual variations determined.

5. SEX SEQUENCE.—It is undoubtedly true in poultry, as well as in other farm animals, that individually enters as an important factor in the development and productivity of the species. It has been more or less definitely established in the case of cattle, for instance, that some individual females tend to produce offspring, the greater percentage of which is of one sex. A knowledge of this fact has placed peculiar values upon certain individuals in herds. The question has been asked many times of poultry investigators as to whether or not there was any tendency among individual fowls to produce eggs that would hatch a large percentage of either male or female chicks. Little, if any, data upon the prevalence or frequence of one sex or the other in the eggs of individual hens is at hand. In order to obtain accurate and more complete data on this problem an experiment is now under way. Ten typical Single Comb White Leghorn pullets, hatched early in the season, have been selected for this observation. It is the general plan of this experiment to trap-nest all birds, which, by the way, are mated to a strong, vigorous, healthy, un-related cockerel, marking every egg with the number of the hen and the date on which it was laid. Each egg will be incubated and the sex and quality of the chick hatching from that egg will be recorded. All eggs will be incubated at a regular interval so that the age of the eggs will not enter as a factor in this experiment. The following definite objects, which are, perhaps. best enumerated as the questions listed below, *will be borne in mind as the work progresses:*

1. How long after the original mating with the male bird do the eggs become fertile?

2. Is there a noticeable difference in this regard between individual females?

3. Do some females tend to produce eggs that are all of one sex?

4. Is there any apparent regularity in the variation of the sex of the eggs produced in sequence?

5. Is there apparently any seasonal influence upon the sex of eggs produced?

6. Does heavier production apparently influence the sex of eggs produced?

7. Is there a tendency in some individual hens to produce a large percentage of infertile eggs? Of fertile eggs?

8. Is there a tendency in some individual hens to produce strong, vigorous, hatchable eggs, as against a tendency to produce weak-germed eggs?

9. Is this characteristic of cycle in sex production, if there is such, inherited? If so, in what manner?

10. From the results of these observations, what practical conclusions may be drawn?

Nutrition Problems

The following problems pertaining to poultry feeding and nutrition have been carried on during the past year with varying success:

1. Milk Products.—Poultry raisers are continually seeking new and improved methods of feeding and management. Within the last few years great interest has been directed by poultrymen to the use of milk and milk products as foodstuffs for poultry of all kinds and ages. Sour skimmed milk has been used with decided success as a supplementary food for laying hens. The results of this work are outlined in the last annual report in some detail. In many localities it has been practically impossible to obtain anything like a constant supply of this material for poultry feeding. The result has been that inquiries have been made as to the relative and comparative value of milk products which are offered on the market for poultry feeding purposes.

During the past year a rather extensive experiment was conducted in which tests were made of the feeding value of skimmed milk powder and milk albumen, two commercial milk products, as compared with meat scrap rations. The milk powder is a finely ground, dried milk. In this work it was used as a component part of the laying mash, rather than in the liquid form, which is often recommended. The milk albumen is a rather coarsely granulated product of the same general nature as the milk powder. Both are high protein-bearing foodstuffs.

One pen of 30 birds of the Barred Plymouth Rock breed and a pen of similar size of the Single Comb White Leghorn breed were given what was called the milk albumen mash. It was composed as follows:

Wheat bran, 20 lbs.; wheat middlings, 20 lbs.; ground oats, 10 lbs.; corn meal, 10 lbs.; gluten feed, 10 lbs.; alfalfa, 10 lbs.; milk albumen, 20 lbs.; total, 100 lbs.

Pens of the same size and breeds were given the following milk albumen and meat scrap mash:

Wheat bran, 20 lbs.; wheat middlings, 20 lbs.; ground oats, 10 lbs.; corn meal, 10 lbs.; gluten feed, 10 lbs.; alfalfa, 10 lbs.; meat scrap, 20 lbs.; milk albumen, 10 lbs.; total, 110 lbs.

Similar pens were given the following milk powder mash:

Wheat bran, 20 lbs.; wheat middlings, 20 lbs.; ground oats, 10 lbs.; corn meal, 10 lbs; gluten feed, 10 lbs.; alfalfa, 10 lbs.; meat scrap, 20 lbs.; milk powder, 10 lbs.; total, 110 lbs.

The remaining two pens were given the following standard New Jersey dry mash. These were used as a check on the milk products mashes outlined above:

Wheat bran, 20 lbs.; wheat middlings, 20 lbs.; ground oats, 10 lbs.; corn meal, 10 lbs.; gluten feed, 10 lbs.; alfalfa, 10 lbs.; meat scraps, 20 lbs.; milk total, 100 lbs.

All pens received the same basal grain ration, and all pens were continued for one year. Definite records were kept of food consumed and eggs produced. At the close of the year the results were calculated, and from a study of the data accumulated on these records the following conclusions were made:

1. There were apparently no positive results in this experiment.

2. The milk albumen mash was evidently of as great value as the standard meat scrap mash.

3. The two mashes of milk powder and milk albumen, plus meat scrap, were of practically the same value as the others.

4. There was no noticeable difference in the amount of mash consumed in the various pens.

5. The difference in the production of the pens could probably all be traced to the presence in certain pens of especially high-producing birds. This meant that the differences in egg production in the various pens were due, not to the mashes fed, but to the high production of the individuals.

6. The commercial milk products, at least to a certain extent, may take the place of meat scrap in the rations of laying hens. The average cost of such products, however, is slightly greater at the present time than the meat scrap rations.

2. A Test of Pineal Gland Secretion on the Growth of Young Chicks.—Numerous commercial efforts have been started to put on the market various commercial forcing materials made from certain glands which are supposed to cause a rapid growth in young chicks. With an idea of trying out one of these commercial products, an extensive experiment was conducted during February and March of 1916 to determine the effect, if any, of varying strengths of pineal gland feeding to growing chicks. The results were measured by mortality, gain in weight, and general health of the flock. Ten brooders of 50 chicks each were used, 5 flocks being fed varying strengths of the special preparation being tested and 5 pens brooded as controls. The pineal gland preparation, as used, was taken from slaughtered sheep. The material fed was mixed with small quantities of wheat bran, slightly moistened with skimmed milk. All of the results of the observations following this feeding test fail to show any appreciable increase in growth, or other advantage

from the feeding of the pineal gland secretion. The cost of the product, if used with large flocks commercially, would have been a point against its use, and its failure to show strong positive advantages would tend to discourage its commercial use in the form, at least, in which the gland preparation was tested out.

3. SOUR SKIMMED MILK FOR CHICKS.—During the past season several thousand chicks were brooded and reared on the College Farm. During the spring season an effort was made to obtain sour skimmed milk for use in the chick pens up until the tenth or twelfth week of age. In order to do this it was necessary, during the greater part of the time, to pay 3 cents per quart for this product. It was interesting to watch the results in order to determine whether or not sour skimmed milk at that price, was an economical addition to the chick rations. Careful and constant observations of all flocks were made throughout the season. The results checked in a remarkable manner the conclusions reached in last year's work.

1. Skimmed milk, in souring, undergoes certain definite changes due to the activities of bacteria that are found in all milk. The most important changes are the formation of lactic acid from the milk sugar, and the breaking down of the caseins and other protein substances into simpler and more easily digested compounds.

2. The lactic acid in sour skimmed milk is thought to have a very beneficial effect upon the digestive system of the chick. Undoubtedly it aids in the digestion of other foodstuffs which the chick may eat. If this is not done directly, it may be accomplished by the increased efficiency of the digestive system. It is also held by some investigators that the lactic acid has a detrimental effect upon the bacterial flora of the digestive tract. Particularly is this thought to be important in cases of bacillary white diarrhœa where the *Bacterium pullorum* infects the digestive tract.

3. Sour skimmed milk is an economical supplement to the rations of young chicks, particularly during the first 10 or 12 weeks of their lives. The result of adding this material to the ration is increased rate of growth, and strong, vigorous development during the most critical period of the chicks' lives. It lowers mortality and produces bigger chicks.

4. Sour skimmed milk should be fed to all young chicks in convenient pans or fountains. Containers used for sour skimmed milk should be washed each morning and filled with a fresh, clean supply. If necessary, withhold water for the first week in order to force the chicks to drink the milk. Keep a supply of sour skimmed milk always before the young chicks. It is economical and will pay.

4. QUALITY IN MEAT SCRAPS.—Meat scraps are recognized as the most efficient and most economical source of protein in the poultry ration. This department has, from time to time,

shown as a result of somewhat extended experiments, the great value of meat scraps in the poultry ration. Appreciating the fact that meat scraps differ in quality, an extensive study has been made during the past year to determine the value of different commercial brands.

By the term "meat scrap" is meant the ground residue from animal tissues exclusive of hoof. If it contains any considerable amount of fowl, it should be designated as fowl scrap. The term "beef scrap" is a misnomer, because there is no scrap on the market which contains only beef.

Meat scrap, as it is purchased on the market, is made up chiefly of butchers' trimmings, either from large packing houses, or from retail butcher shops. In some cases small amounts of horse meat are used in the manufacture of meat scrap. The kind of meat is not so important, except in the case of pork, which is undesirable in large quantities because it increases the fat content of the meat. The meat must be clean and properly rendered, or it is unfit to feed.

The rendering of meat scrap consists in general of the following process. Large kettles or tanks are filled with tallow and this is heated to the boiling point, then the butchers' trimmings and other meat are gradually added to the boiling tallow. The mixture is constantly agitated by some mechanism within the tank so that the whole mixture is rendered uniformly. This process is continued for from 5 to 7 hours, depending upon the amount of moisture which the meat contains. The fat is drawn off and the rendered meat is placed in a hydraulic press, where it is subjected to a pressure of from 3,000 to 4,000 pounds per square inch for about 5 hours to squeeze out all the surplus fat. The cakes of meat are then taken from the press, allowed to harden, and afterward ground and tagged, ready for shipment. Some concerns use a filler in making up their meat scrap, claiming that it would otherwise be too concentrated, but this practice is unnecessary and undesirable.

In order to study the relative value of various brands of meat scraps, 12 different commercial grades were secured, which will be designated in this study by numerals only. Extensive physical tests were made to determine the amount of bone, meat and foreign materials. Chemical analyses were made to show the amount of protein and fat present. The variation of protein and fat is shown in Table I.

It is important to note the wide variation of protein and fat, and of still more interest is Table II, which might be called an efficiency determination. based on the cost of a pound of protein present.

From a study of Table II, it will be seen that brand No. 6 furnished protein at \$.044 per pound, while brand No. 5, furnished protein at \$.064 per pound. From a result of this study, which is reported but briefly, it should be appreciated that a product which furnishes such an important part of the bird's diet

Table I

Chemical Analysis of Meat Scraps

Brand No.	Per Cent Protein Guaranteed	Found	Per Cent Fat Guaranteed	Found
1	50.00	50.40	8	11.84
2	43.00	46.94	11	13.85
3	50.00	47.94	14	8.93
4	39.93	40.90	10	17.40
5	45.00	52.10	12	11.87
6	55.00	56.56	14	9.30
7	50.00	51.06	14	20.77
8	55.00	57.50	10	14.00
9	50.00	46.00	15	17.44
10	50.00	49.00	12	16.55
11	50.00	52.56	10	14.92
12	55.00	57.44	10	19.03

should be purchased with a great deal of care. Meat scraps which are high in protein and rather low in fat are the most desirable. Meat scraps without an excessive amount of bone are desirable, for the bone must be bought at meat prices in the scrap, when it can be bought much cheaper as a separate product. The odor of the scrap should be a guide to the purchaser. Only pure, high-grade scrap should be used in the feeding of poultry for any purpose.

Table II

Efficiency Table of Meat Scraps

Based on Cost Per Pound of Protein Content

Brand No.	Lbs. Protein *in Ton*	*Cost Per Ton*	Cost of Protein *Per Lb.*
1	1108.0	\$60.00	\$ .059
2	938.8	\$52.00	\$ .0553
3	857.8	\$53.00	\$ .0552
4	800.0	\$50.00	\$ .062
5	1042.0	\$67.00	\$ .064
6	1131.2	\$50.00	\$ .044
7	1021.2	\$52.00	\$ .050
8	1150.0	\$54.90	\$ .047
9	920.0	\$50.00	\$ .054
10	980.0	\$48.00	\$ .048
11	1051.2	\$58.00	\$ .0551
12	1148.8	\$65.00	\$ .056

5. THE EFFICIENCY OF READY-MIXED POULTRY FEEDS.—Much has been said and is continually said about the relative nutritive value of various commercial ready-mixed feeds. With an idea of determining the actual quality existing in common commercial poultry rations, a study has been carried on in which 11 different commercial laying mashes and their accompanying

scratch grain rations have been completely studied. Mechanical analyses of the various samples have been made, and the exact ingredients and amounts used have been determined. Chemical analyses of the samples have been secured and the exact nutritive values of these rations calculated. *In conclusion, it might* be said that the rations vary greatly in the ingredients used in their composition. The amount of foreign material and undesirable seeds varies from 0 to 10 per cent. The nutritive ratios in the mashes vary from 1 to 2.5, to 1 to 5.6, and in the grains from 1 to 6.1, to 1 to 2.9. The cost of these ready-mixed feeds varies from $33.80 to $41.00 per ton in the case of the mash feeds, and from $36.50 to $46.00 per ton in the case of the scratch feeds. The total cost of the combined scratch and mash feeds consumed by 100 birds per day varies from $0.38 to $0.68. These few figures are given simply in comparison to show the wide range of quality and the importance of the poultryman's paying special attention to the reliability of the ready-mixed feeds which he uses, should he feed such rations, rather than mix his own. Quality of ingredients and efficiency as measured by value received should be the two determining features in buying.

Incubation Problems.

During the year numerous observations have been made pertaining to problems associated with artificial incubation, one of which, the most important, being a study of incubation methods as practiced in New Jersey.

1. METHODS OF ARTIFICIAL INCUBATION AS PRACTICED IN NEW JERSEY.—*During the past six months an investigation* has been carried on among the poultrymen and farmers of this State who use incubators. The purpose of this is to ascertain the methods used, the usual percentage of hatch, type, size, and number of incubators used. One hundred and twenty-nine farms have made reports to date and a variety of methods seem to be in use in different parts of the State. Methods in vogue in one section are entirely different from those used in other sections, due to variations in climate largely, also in humidity, and in the time of hatching. Usual hatches (percentage of fertile eggs) averaged from 50 to 90 per cent, and incubator capacities of the various farms which reported ran from 150 to 45,000 eggs at one setting.

The questions asked of each poultryman were as follows:

Farm reporting.................................. Date.................
Do you cool the eggs? How often? How long each time?
Do you supply moisture? How do you supply it?
How much moisture do you supply?
When do you first supply moisture? When do you stop?
When do you begin and when do you stop turning and cooling the eggs?
What is your usual percentage of hatch (percentage of fertile eggs)?
What kind and what capacity incubator do you use?
Where is it located?
Remarks:

Of the total number reporting (129), 68 poultrymen cool the eggs twice a day during the period of incubation, beginning usually on the third day and stopping on the nineteenth. Of the remainder, 49 cool but once a day, and 12 reported no cooling at all, except while turning the eggs. A large majority, 110, supplied moisture in various ways, ranging from the use of wet rags and sponges to sand trays, sprinkling the eggs and wetting the floor beneath the incubator. Nineteen poultrymen reported the use of no moisture, over half of these being in counties along the coast, where the humidity is higher than that farther inland. Two-thirds of those reporting located their incubators in the cellar of the dwelling house, while the remaining one-third used a specially constructed incubator cellar. The total incubator capacity of all farms reporting is over 346,135 eggs at one setting.

This investigation will be continued until every poultryman and farmer in the State whom it is possible to reach will be given an opportunity to report. The coöperation of farms which have already reported has been very gratifying. Such a census, when completed, will be of inestimable value to the Poultry Department in rendering proper and intelligent aid to poultrymen and farmers in every section of the State when called upon for such, and the reports, when properly digested and tabulated, should prove to be a valuable source of information to all who use the artificial method of incubation.

Figure 1 shows, by means of colored pins, the location of each farm reporting.

2. Effect of Method of Turning on Position of Embryo.—During the past year a series of experiments to determine the cause of the death of chicks in the shell during artificial incubation was started. In the first experiment of the series, the effect of various methods of turning the egg upon the

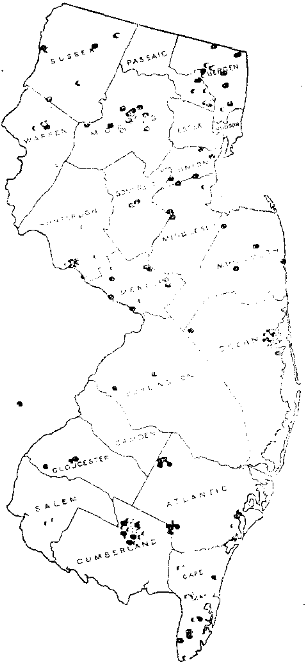

Fig. 1. Map showing location of farms reporting in incubation study.

Table III

Report of Hatching Investigation

County	No. Reports	Total Capacity Eggs	Cooling Yes	Cooling No	Moisture Yes	Moisture No	Location Special Cellar	Location House Cellar	Average Hatches Reported 50 to 60 %	60 to 70 %	70 to 80 %	80 to 90 %
Atlantic,	17	12,304	15	2	14	3	4	13	1	6	8	2
Bergen,	10	128,268	8	2	9	1	3	7	1	2	6	1
Burlington,	2	740	2	0	2	0	0	2	1	1	0	0
Cape May,	11	12,408	11	0	7	4	3	8	2	0	4	5
Cumberland,	19	31,411	19	0	19	0	5	14	3	3	13	0
Gloucester,	3	810	2	1	3	0	0	3	*	0	2	0
Hunterdon,	8	35,740	8	0	5	3	4	4	2	3	3	0
Mercer,	9	23,860	7	2	9	0	5	4	0	3	3	3
Middlesex,	4	9,800	4	0	4	0	1	3	0	3	0	1
Monmouth,	4	5,524	4	0	4	0	0	4	**	1	1	0
Morris,	5	960	5	0	4	1	0	5	0	0	3	2
Ocean,	11	45,000	10	1	9	2	3	8	2	2	6	1
Passaic,	7	6,020	6	1	6	1	2	5	1	4	1	1
Salem,	2	1,300	2	0	1	1	1	1	0	1	1	0
Somerset,	1	240	1	0	1	0	0	1	0	1	0	0
Sussex,	5	8,610	5	0	4	1	1	4	0	0	4	1
Union,	5	18,000	3	2	5	0	5	0	0	2	1	2
Warren,	6	10,050	5	1	5	1	2	4	1	*	4	0
Totals,	129	346,135	117	12	111	18	39	90	14	32	60	19

*1 not given.
**2 not given.

position of the embryo was observed. During the hatching season, approximately 1,000 unhatched eggs were opened and the position of the embryo was noted. These eggs had been turned in various ways. It was noted that a large percentage of the unhatched chicks were in an inverted position in the egg. In other words, instead of the head of the embryo being toward the large end of the egg, as it normally is, the head was found at the small end. In such a position it is next to impossible for the chick to break its way out of the shell.

With this data at hand, the experiment to determine the effect of turning was outlined and started. The eggs used were from a pen of healthy, vigorous breeders and were uniform in size and shape. The following methods of turning were used:

1. Turning on the long axis. Each egg was allowed to rest on its side and was turned gently from side to side.

2. Turning on the short axis. Each end was turned end over end.

3. Rolling by hand. In this case all the eggs on the tray were turned by passing the hands over them with a circular motion, rolling them indiscriminately from one end of the tray to the other. No attention was paid to whether the eggs rolled end over end or on their sides.

4. Turning by inverting the tray into an empty one. This was done by placing an empty tray of the same size over the full one, grasping the two closely and inverting them.

Four groups of 450 eggs each were turned according to the methods described above. The results obtained are shown in Table IV.

It will be noted that to date there is no apparent advantage attached to any one of the methods involved. However, the experiment will be continued until conclusions, positive or negative, are secured. A larger amount of data than that already on hand will be necessary before any conclusions can be drawn.

3. Variation in Water Content of Eggs as Determining the Efficiency of the Hatch.—For some time it has been assumed by certain practical poultrymen and by some research men that the water content in the egg, on account of the fact that it determines the density of the albumen, affects very definitely the per cent of hatch. To test this theory, a laboratory problem was carried through which had for its object the determination of the normal variation of water content in the albumen of the hen's egg, and, if possible, to determine the factors which cause or affect this variation and what correlation exists, if any, between the per cent of water and the per cent of hatch. Special pens were mated from which to secure the eggs

for study. These birds were carefully fed and housed, carefully trap-nested, and records kept of production. Every other egg laid by these flocks was incubated, and every other one was analyzed for the water content. After securing and plotting data covering ranges in water content from a considerable number of individuals, the results seemed to show a very slight variation in the water content in individual hens or in different hens. Any slight existing variations seem to be due to rapidity of pro-

Table IV

Percentage of Chicks in Various Positions

Test No. 1

Tray No.	% Inverted	% Partially Inverted	% O. K.
Eggs Turned on Long Axis			
1	10.3	20.6	68.9
5	16.6	5.5	77.7
Average	13.5	13.1	73.3
Eggs Turned on Short Axis			
2	13.6	40.9	45.4
6	4.7	42.8	52.3
Average	9.7	41.9	48.7
Eggs Turned by Hand (Rolling)			
3	22.2	33.3	44.4
7	19.0	33.3	47.2
Average	20.6	33.3	45.8
Eggs Turned by Inverting in Empty Tray			
4	22.7	13.5	63.6
8	32.1	32.1	35.7
Average	27.4	22.8	54.7

Test No. 2

Tray No.	% Inverted	% Partially Inverted	% O. K.
Eggs Turned on Long Axis			
1	6.2	25.0	68.7
5	5.2	5.2	89.4
9	15.0	19.2	69.1
13	14.2	9.5	76.1
Average	10.2	14.7	75.8
Eggs Turned on Short Axis			
2	20.0	33.3	46.6
6	50.0	50.0	0.0
10	11.7	11.7	76.4
14	0.0	31.8	68.1
Average	20.4	31.7	47.8
Eggs Turned by Hand (Rolling)			
3	15.3	26.9	57.6
7	0.0	12.5	87.5
11	25.0	25.0	50.0
15	22.7	22.7	54.5
Average	15.8	21.9	62.4
Eggs Turned by Inverting in Empty Tray			
4	36.3	22.7	40.9
8	50.0	16.6	33.3
12	19.0	28.5	52.3
16	26.6	26.6	46.6
Average	33.0	27.2	43.8

duction, rather than to any known factor. The correlation tables fail to show any definite correlation between increased water content and decreased hatchability. A general conclusion might be drawn, namely, the variation of the water factor in eggs is small and offers such a narrow range that it seems to have little, if any, direct effect upon hatchability. The average water content in the albumen was 87 per cent, with a slight variation of from 1 to 4 per cent either way, but this variation was correlated in no apparent way with the per cent of hatch.

4. Observations on Effect of Time of Hatching on the Performance and Profit from Resulting Pullets and Cockerels.—For a number of years this Station has strongly urged the New Jersey poultrymen to practice relatively early hatching, and in the case of Leghorns has recommended hatching about one-quarter to one-third of the flock in late February, with the purpose of securing pullets which would lay well during August, September and October, or while the yearling hens are molting and before the later pullets have started. This practice is still proving exceptionally profitable, but many farms who have hatched pullets earlier than this have been confronted with disastrous results. It is with the idea of securing data pertaining to the peculiar behavior of pullets hatched at different seasons that an extensive research problem is being started this fall to cover both cockerels and pullets hatched during the months of December, January, February, March, April, May and June. Not only will the performance of the pullets be considered, but the cost of growth and the selling value of surplus cockerels will receive due consideration.

It is requested that any person in the State having extended experience with pullets hatched at different seasons will communicate their findings to the Poultry Department of the Experiment Station in order to give us a wider vision in analyzing these commercial problems which confront all of our poultry interests.

Poultry Management Problems

1. Error Factor in Experimental Analysis.—It is a recognized fact that serious errors can easily be made in the analysis of experimental results, if due care is not given to the consideration of the uniformity of pedigree, vigor and growth of the stock used. During the past few years this department has been running many minor observations to find out the normal variation in production of flocks of Leghorns and Barred Plymouth Rocks, all fed and managed in identically the same manner. The results

of these observations have shown exceedingly great differences in the fecundity factor. Hence, it seems to us impossible satisfactorily to analyze feeding and housing experiments where from 10 to 50 birds are used in each flock, if consideration is not given to the variation in production, due to the inherited fecundity factor. Our work seems to show that this same possibility of error is present in the analysis of experimental data along certain lines of incubation and brooding, as well as housing and feeding.

In order to get authentic and unquestionable data pertaining to this normal variation of flocks cared for identically the same, an extensive project has been started at the close of this present year, with the use of both White Leghorns and Plymouth Rocks, in which over 800 birds, divided into flocks of 50 birds each, will be housed in similar houses, fed and managed identically the same, and under the same conditions, the only factor of difference being that of parentage. From an analysis of the production of these pens some definite data will be secured showing just how wide a normal variation should be expected before the result which is apparently secured from different methods of feeding or care could be attributed to the change in method. The same type of work is also being carried on in incubation and brooding, mammoth incubators and colony brooder stoves being used for the work. It is believed that this work will show a definite variation, that it will be possible to evolve an inheritance error factor to apply in the analysis of poultry management research problems.

2. A Standardized Poultry Plant.—It has been the purpose of the Poultry Department ever since its conception, to develop, wherever possible, standard equipment and standard methods of management. The New Jersey Multiple Unit Laying House has been adopted in many sections of the country as a standard type of equipment. The same may be said of the New Jersey rations developed on a standardized basis which has been used and accepted as a standard from which to work. Numerous requests have come to the department at frequent intervals asking knowledge as to the amount, kind and nature of equipment which should be needed for a successful poultry farm under a certain set of conditions. This information is vital to those contemplating making a start in poultry raising and to anyone wishing to revise the business and to put it on a more firm financial basis. With the idea of solving definitely many of these problems presented and with the idea of standardizing buildings,

stock and equipment needed for a poultry plant of 1,000 birds, this department has entered into a new project, known as the "standard unit poultry plant project." This project will be divided into two main lines of study, first, the securing of accurate data covering a 12 months' period from as many successful commercial poultry farms in the State as possible. These data will comprise a complete inventory of the farm, including buildings, stock, tools, etc., covering also the amount and use of land, and a detailed study of the operation charges, with special reference to the source and amount of revenue. From these data compiled the second phase of the study will be to evolve the ideal or standard factors which should apply in all of the problems studied for a plant of certain size. With this information at hand it will be possible for anyone starting out in the business to develop his plant along approved, safe, practical lines. The importance of keeping complete inventories and in conducting a poultry farm along definite lines of business management will be the important results which will be derived by the poultrymen on the farms studied.

3. Increased Cost of Production.—During the past year economic conditions have been such that the market prices of the standard grains and by-product feeding stuffs have steadily advanced. This has created a new problem which poultry feeders have found to be a very puzzling one. In order to secure profits from poultry production it is necessary to handle the feeding factor with greatest care. Table V gives the average prices of the foodstuffs which were required to make up the New Jersey feeding rations during the past year. The figures given are the average price per 100 pounds for each month The average cost of morning and night scratch rations and the dry mash also is indicated in the table. From a study of these figures, which are the actual prices paid by the department to local feed merchants, it is noticed first of all that the standard grains, wheat, corn, and oats, were those feeding stuffs which advanced to the highest prices above normal. The products from which the dry mash was made did not advance so phenomenally as the whole grains themselves.

One of the most frequent questions that have been asked of the department has been with regard to a substitute for wheat in the rations given to laying fowls. While it is realized that the price of wheat is and has been extremely high, it is not considered that there is a proper substitute which has been sufficiently tried out to warrant advising its use. Barley comes as near

to filling the place of wheat as any other one grain. In this season of high feed costs poultrymen should demand the highest quality of product. More strict attention must be paid to methods of feeding and avoiding waste in order to use the high-priced feeding materials to best advantage and with least loss.

Table V

Cost of Standard Poultry Feeds

Feeds	1915 Nov.	1915 Dec.	1916 Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
Wheat bran, ...	$1.25	$1.25	$1.26	$1.25	$1.25	$1.25	$1.25	$1.30	$1.25	$1.26	$1.35	$1.45
Wheat middlings,	1.35	1.25	1.30	1.48	1.35	1.36	1.30	1.56	1.56	1.35	1.45	1.57
Ground oats, ...	1.55	1.55	1.55	1.76	1.68	1.58	1.65	1.85	1.90	1.87	1.35	2.13
Corn meal, ...	1.50	1.52	1.57	1.58	1.59	1.67	1.75	1.80	1.85	1.86	2.05	2.00
Gluten feed, ...	1.55	1.56	1.56	1.56	1.76	1.68	1.50	1.69	1.75	1.56	1.70	1.70
Ground alfalfa, .	1.40	1.47	1.47	1.48	1.48	1.48	1.48	1.49	1.45	1.45	1.45	1.52
Meat scrap, ...	2.90	2.96	2.96	2.85	2.97	2.97	2.60	2.95	2.70	2.97	2.70	2.96
Wheat, ...	1.95	1.75	1.76	1.76	1.95	1.98	1.85	2.07	2.15	2.07	2.40	2.06
Cracked corn, ..	1.50	1.52	1.54	1.58	1.59	1.67	1.75	1.85	1.80	1.86	2.05	2.00
Oats, ...	1.38	1.45	1.47	1.67	1.45	1.58	1.80	1.80	1.80	1.72	1.75	1.75
Cost of Mash, ..	1.70	1.702	1.719	1.754	1.765	1.757	1.668	1.845	1.785	1.788	1.755	1.931
Cost of No. 1, ..	1.66	1.60	1.61	1.71	1.70	1.74	1.82	1.93	1.97	1.89	2.07	1.90
Cost of No. 2, ..	1.58	1.50	1.57	1.64	1.84	1.72	1.78	1.89	1.88	1.87	2.06	1.95

Poultry Pathology Observations

1. Post-Mortem Diagnoses.—During the past year this department has made between 250 and 300 post-mortem diagnoses. Other diagnoses have been made by letter. The advisory work has extended into nearly every section of the State, at least to some degree.

An examination of the reports of these diseases indicates that the range of diseases, which have broken out on New Jersey poultry farms during the past year, is very wide. Several instances of at least 25 common diseases have been cited and studied. The following discussion describes briefly some of the most prevalent and most economically important poultry diseases which have thus been brought to the attention of the department.

Prolapsis of the Oviduct.—During the spring season many cases of prolapsis of the oviduct were reported. This trouble is usually often found during the spring season of heavy egg production, being most common in flocks of pullets, many of which may be coming into heavy production for the first time. It also breaks out in cases of individuals that are weakened through the strain of previous production, and in some cases where exceptionally large eggs are produced. Constipation in the digestive tract tends to cause an irritation and inflammation of the oviduct which also may result in prolapsis. The main symptom

is the appearance of a bloody mass of flesh protruding from the vent. It is either a partial or complete eversion of the lower part of the oviduct, that channel through which the egg passes, and in which the albumen, shell membranes, and shell itself are secreted. The appearance of blood in the region of the abdomen quickly attracts the attention of the other birds in the pen. This often leads to the formation of cannibalistic habits. The general advice given in cases of prolapsis of the oviduct is:

1. Keep constant watch over the heavy-producing flocks especially during the spring season, removing any birds suffering from prolapsis at first sight. This will do much toward preventing mortality, and the formation of cannibalistic habits.

2. Place the affected birds in dry, clean quarters, each bird in a separate place.

3. Bathe the affected parts with a mild disinfectant solution, if there is an accumulation of filth or dirt in that region.

4. Nature will heal the wound usually in a satisfactory manner, if the bird is kept quiet and in clean surroundings.

5. The use of carbolated vaseline as an ointment will often assist in the healing of prolapsis wounds.

6. Birds which once suffer from this trouble seem to be subject to relapses, and for this reason it is a question whether such birds should be returned to the pen or marketed after having been cured.

7. It is practically impossible to avoid all cases of prolapsis, but if proper care be taken, serious losses from this trouble can often be checked without great labor or expense.

Chickenpox is another serious poultry disease which has been found from time to time during the year. As it has been discussed in other parts of the report, it is mentioned here only as having come to our attention a great many times during the year.

Contagious eye roup seems to be an annual visitor on many poultry farms. It is a disease probably caused by a pus-forming organism of some kind which gains entrance to the nasal cavity and thus to the region of the eye. It forms an enlarged eye, with the accumulation of a cheese-like deposit, which is accompanied by a decidedly disagreeable odor. It is undoubtedly spread in the pens through the medium of the drinking fountains, feed utensils and litter, besides by individual contact. The following suggestions are made with the idea of assisting in preventing the spread of this serious disease through poultry flocks:

1. Provide all poultry flocks with an environment that is dry, clean, and sanitary, avoiding drafts and excessive moisture, particularly during the

cold months. Unfavorable conditions produce colds which weaken the vitality of the birds and make them susceptible to contagious eye roup.

2. Isolate all birds which show the first symptoms of this disease, keeping them in sanitary quarters by themselves.

3. Keep the water fountains thoroughly clean at all times, either disinfecting or scalding them at least twice a week. Keep the litter in a dry, sanitary condition, removing and changing the same after an outbreak of roup has been noticed.

4. Use a disinfectant solution carefully in the house in which the disease has broken out. A 5 per cent coal, tar dip solution, applied with a hand spray, is often used with splendid results.

5. Individual birds suffering from roup can often be cured by the use of disinfectants applied to the affected parts. This is true if the disease has not advanced to its later stages.

6. Contagious eye roup, if it runs a course of several days or even weeks, usually lowers the vitality of the bird to the extent that egg production is entirely stopped, and in many cases never resumed.

7. The treatment of birds suffering from contagious eye roup is rather unsatisfactory. The importance of close study of such cases lies in trying to prevent a further spread of the trouble by improved sanitary methods and careful observation.

Tuberculosis has taken many victims from poultry flocks during the past year. This is a rather slow acting, disease, contagious in nature, on which little specific information is at hand. The average symptoms of avian tuberculosis shown before death are a gradual loss of flesh, and an increasingly bright eye. Upon post-mortem examination, tubercular birds will be found to have livers somewhat enlarged and covered with deep, hard, raised, yellow spots. The spleen is usually similarly affected, and the connecting tissue between the folds of the intestines is often found to be covered with tubercular lesions. The removal of light weight birds from the flock and their proper disposal, together with increased care in keeping all environments thoroughly sanitary, are the best preventive measures yet known for checking the spread of avian tuberculosis. It is also essential to be careful in purchasing new stock, as much of this disease is spread through the careless and indiscriminate exchange of stock from farm to farm.

Peritonitis. Many cases of peritonitis have been studied and reported throughout the year. There are a number of causes of this fatal poultry disease, among which are ruptured intestines or oviducts, which allow foreign matter to accumulate in the abdominal cavity, inflammation of the peritoneum, and injuries to the abdominal walls. The symptoms of peritonitis are not distinctive until post-mortem examination reveals them. Serious

inflammation of the abdominal tissues, with usually an accumulation of decayed matter, is the common symptom. This is a disease for which little treatment can be given, because of the impossibility of positively diagnosing the trouble before death.

Among the most important of the remaining diseases which have been diagnosed are ovarian tumors, tumors of the digestive tract, crop bound, severe liver troubles, bronchitis, scaly leg and black head. The latter has been found in several turkeys which have been examined.

Considerably over 200 letters have been written during the year dealing with disease problems alone. These letters have covered a wide field of disease subjects and have included in each case, where possible, definite advice, not only as to treatment of sick birds, but as to the preventive measures which might help in cutting down the future losses.

From a study of the accumulated reports, the following suggestions seems pertinent at the present time:

1. Poultry diseases annually take large numbers of fowls from New Jersey farms, but this number is gradually decreasing as more knowledge is gained of the diseases and methods of preventing them.

2. The isolation of all sick birds from healthy flocks stands out as the first step in checking epidemics of disease. So little is known of methods of transmission of many of the diseases that few, if any. exceptions to this rule of isolation ought to be made. Every farm should maintain a hospital which need only be a convenient place in which sick birds can be placed, either for treatment or examination. It need not be expensively constructed or equipped, but should provide facilities for keeping such birds away from contact with healthy flocks.

3. Every bird that is sick or found dead should be carefully examined by the poultryman. It is essential to determine, if possible, the cause of the deaths or sickness in order to study methods of preventing such causative agencies from acting in the future.

4. Extreme care should be used in the disposal of all sick and dead birds. It is preferable to burn all carcasses which are to be disposed of. This will remove and destroy any possibility of that carcass transmitting disease. If burning is out of the question because of local conditions, carcasses should be buried in pits at least 2½ feet below the surface of the ground. Place considerable quicklime over the carcass before filling up the hole. Never bury the birds on poultry ranges, if possible to avoid it, but rather in secluded spots which are not often visited by the birds.

5. This department is glad to be of any service possible to poultrymen of the State in the diagnosis of disease cases. In order to facilitate this work and make possible a more careful examination and diagnosis, it is requested that all poultrymen who send in birds for examination, observe the following suggestions:

A. Send affected birds before death, if possible, but in case of sudden death, etc., send the carcass at the earliest possible opportunity. During the warm months carcasses should be packed in ice in order to prevent decomposition.

B. Each bird or carcass should be accompanied with as complete a description of the trouble as can be given. It is absolutely necessary to know the nature of the outbreak, the length of time the bird has been affected, and other details concerning it.

2. CONTAGIOUS EPITHELIOMA (CHICKENPOX) IN NEW JERSEY.—Of all the poultry diseases which occur in New Jersey, there is probably none which is more widespread or which comes back with greater regularity at definite periods and in specific sections, and there is none which probably causes a greater financial loss to the poultry producer, than chickenpox. For a number of years the Vineland district of Cumberland County has been subjected each summer and early fall to epidemics of this infection. The Poultry Department has, at various times, coöperated in a limited way with individuals in the district to stamp out this disease in their flock. During last fall such a serious infection was encountered that it seems appropriate that this department should spend more time in coöperation with the poultrymen and in determining methods of prevention. With this in view, the poultry husbandman spent considerable time in the district during the past summer studying the behavior of previous infections, making maps of the district, and suggesting possible means of transmission and definite methods of prevention and control. These methods have been followed rigorously by the majority of the poultrymen in the district, and the work which the department has done has been given wide publicity through the medium of the press and the Vineland Poultry Association. No epidemic of chickenpox has yet made it appearance in Vineland at this writing, November 1, 1916.

Carefully laid plans, however, are in readiness to study an epidemic should it occur, with the idea of determining definitely its source and spread and the value of methods already recognized for its control and its suppression.

The poultry interests of Vineland are coöperating with the department in this work very fully, the least trace of a possible infection being reported immediately; outbreaks are plotted on maps of the Vineland district, and all further outbreaks will be plotted and studied in this manner. The methods which have been recommended and which seem most valuable for checking the disease are careful sanitation about the yards and poultry houses, ploughing the yards in the late summer and seeding

them with a cover crop, disinfecting the house in the late summer before the incoming pullets are brought in off the range, and maintaining dry, well ventilated conditions within the house. Further precautions should be taken in the form of keeping a careful watch over all birds and immediately treating any which show symptoms of the disease by removing the scab and painting the wound with iodine and by immersing the heads of the individuals in a dilute solution of FER-SUL. We believe that the completion of this study will result in greatly reducing the scourge of chickenpox in the Vineland district, if not entirely eliminating it as a serious hindrance to profitable poultry production.

Contagious Epithelioma on the Station Poultry Farm.—During September an extensive outbreak of chickenpox was found in the flocks of Leghorn pullets on the Station farm. The cause of this outbreak has not been definitely determined. Out of 700 pullets which were individually handled and examined, nearly 300 were removed as being suspected of cases of chickenpox. This careful individual inspection was made upon the finding of the first case. This meant that no advanced cases of chickenpox were found, but everyone was taken in early stages. Each bird was immediately treated, every head being dipped in a solution of FUR-SUL, which is a disinfecting material. A teaspoonful of a 1 to 32 solution was administered internally, with the idea that as it was an iron compound it might act as a tonic for the blood. Frequent re-immersions were made during the next two weeks, at the end of which time all birds were in apparently normal health again. It is thought that the clearing up of this epidemic was due primarily to the fact that it was found before any advanced stages had been reached. Undoubtedly many birds were included in the isolated flock which did not have the true disease, but no chances were taken, and all birds that had any sores upon the head whatever were isolated. All pens in which affected birds were found were immediately cleaned and thoroughly disinfected. At the present writing, November 1, 1916, no cases remain.

During the present year laboratory studies have been planned and are under way for a detailed study of this disease. An attempt will be made to isolate the organisms which are responsible for the disease. It is also hoped that a detailed description of these organisms, their habits and methods, can be made. In sequence, an attempt will be started to determine whether or not a vaccine can be prepared which will successfully prevent the disease by immunizing birds. At the present time the depart-

ment is coöperating with the Squibb's Laboratories in the matter of a vaccine preparation.

3. Observations in the Causes and Prevention of Chick Troubles and Vices.—During the past spring several interesting observations were made in the chick flocks as to the cause of certain common chick troubles. One of these which is most frequently reported is what might be termed cannibalism. This seems to be particularly prevalent in the large flocks of chicks which are raised by the colony method. It usually takes the form of chicks picking each other, either on the wings or at the base of the tail. After a bit of blood has been drawn, the attention of the whole flock of chicks seems at once attracted toward that chick. One case is usually followed by many more, unless care is promptly taken to prevent it. Large numbers of chicks together, insufficient room for such large flocks, and the lack of something to do, seem to be the chief reasons why this cannibalism gets started. In order to counteract the cause, the following suggestions are made:

1. Keep close watch over all large flocks for the first few weeks, removing at first sight any chicks which give indications of having been picked, or on which there is any sight of blood.
2. Get the flocks out-of-doors as soon as possible where they will have more room to run around and more to take up their time and attention.
3. Place a small pan of beef scrap in the pens. This will sometimes aid in checking cannibalism.
4. Toe-picking is akin to other forms of cannibalism, and can be prevented only by very close observations and careful management.
5. No medical treatment will prevent this trouble.

Leg weakness is another serious chick trouble. It is usually caused by floor drafts, damp, cold floors, or improper feeding methods. In some cases it may be due to inherited weakness of the chicks. It is usually found in chicks that are a week old or over, and is indicated by an inability to use the legs quickly. Much can be done toward preventing leg weakness if the following precautions are observed:

1. Brooder houses should be so constructed as to prevent floor drafts and damp, cold floors.
2. Brooders should be operated uniformly and with the proper degree of temperature.
3. Chick rations should be used which are suited to the young chicks.

Marketing Problems

1. Egg Preservation.—During the spring of 1915 this department began a series of tests to study the efficiency of cer-

tain methods to be used in the home preservation of eggs. The first problem was to test water glass or sodium silicate as a medium for egg preservation, and to test silicate solutions containing various strengths of alkalinity. In this work the active coöperation of the Philadelphia Quartz Company was secured, and their coöperation consisted largely in providing solutions of various concentrations for the work. Six different jars containing 100 eggs each were put down on March 10, 1915. These were examined at frequent intervals and complete notes made. On April 24, 1916, or 13 months after the eggs were originally put down, one dozen eggs from each jar were critically examined in the presence of members of the poultry department and of the home economics department. The following factors were considered:

1. The condition of the preserving liquid in regard to odor, color, clearness, and general desirable conditions was noted.

2. A candle test was made of all eggs to determine the size of the air cell and the appearance of the contents before the candle light.

3. Displacement tests followed in which the weight of 12 eggs was compared with the volume of water which they displaced.

4. The condition of the exterior of the egg shell was observed.

5. A breaking test was made to determine the toughness of the yolk membrane.

6. The condition of the albumen was observed as to consistency, its division, odor, color, amount of water, and beating qualities.

7. The condition of the yolk was also examined to determine the color, odor, buoyancy, and the strength of the membrane.

8. Representative samples of eggs were cooked in the following manner; soft boiled, poached, and hard boiled; and in all of these observations strictly fresh eggs were compared with the preserved ones.

It is not the purpose in this report to give the exact conditions as found in all cases, as this will be published in a separate publication on the subject at a later date, together with the results of other tests at present under way. It might be said, however, that eggs preserved in stone crocks in a 10 per cent solution of a sodium silicate solution will keep for a period of twelve months in a remarkably fine condition, and will at the end of that period be perfectly suitable for cooking in any manner.

At the end of 6 months, which is the normal length of the period during which it is necessary to preserve eggs for home use, it is impossible to distinguish in all cases the preserved egg from a strictly fresh egg, even when the eggs are broken and poached. It would seem to be a very desirable thing for the housewives to practice home preservation in sodium silicate much more exten-

sively than is now practiced. It would certainly be a great saving financially and would help to equalize the supply and demand for the poultryman's product during the seasons of low and high production.

2. Egg Preservation.—In addition to the tests which have been made with sodium silicate as an egg preserver, several other types or methods of preservation were tested out.

1. Fleming's Egg Preserver is a commercial product, the use of which is known as one of the methods of dry preservation. It consists of anointing the surface of the eggs with a material which has the appearance of being a thick oily substance. The principal theory of preservation in this case is that if the surface of the shell is covered with a material which will not evaporate, the inner contents of the egg will not evaporate and will be naturally preserved. Several dozen eggs were put down in February with this preservative.

2. A preserver of the same type was prepared by home-made methods and used on a similar number of eggs. As the results of this experiment are not yet fully completed, the composition of this mixture will be withheld until the records are completed.

3. An equal number of eggs were preserved in a lime solution made by placing a piece of lime approximately the size of a walnut in a gallon of water, to which one-half cup of salt had been added.

4. Eggs were preserved also by packing in dry salt.

5. The Morning Glory Egg Preserver, which is of an oily nature, also was tested. It is one of the ointment preservatives.

6. An equal number of eggs were preserved with Goudy's Egg Preservative, sodium silicate, as a check upon the other types.

Frequent examinations have been made during the summer of the condition and quality of eggs preserved by the different methods. The following results seem to hold:

1. The eggs which were preserved with Fleming's Egg Preserver, Morning Glory, and home-made preservative, all kept in splendid condition. Several eggs from each lot were tested as to evaporation, condition and consistency of the albumen and yolk, and the flavor of both. In most cases the albumen showed the effects of age in that it was more watery than in fresh eggs. The membrane surrounding the yolk was not as tough as in the fresh egg, but in most cases the eggs still held considerable rigidity. Undoubtedly this method of preservation, if carefully performed, can be used with good results by the housewife. It does not necessitate the use of jars or liquids, as eggs can be packed in cartons and stored in cool places. It is not difficult to apply and apparently does not alter the quality of the egg in any way.

2. The eggs which were preserved in the lime solution also showed fair quality upon examination. The odor connected with the jars in

which this preservative was used was rather undesirable, and may have affected the eggs to some extent.

3. Goudy's Egg Preserver checked the good results enumerated in the experiment outlined above.

4. The eggs which were packed in salt were not thought to be a success, as the evaporation was considerably in excess of that of the others, and the interior quality was not good, many yolks adhering to the shell.

The home preservation of eggs is a problem which many housewives will study in detail during the next year. The high price of eggs during this present winter will bring forcibly to their attention the possibility of preserving eggs when low prices prevail.

2. Capon Production.—One of the most interesting branches of poultry raising is that of capon production. There are a number of farms in New Jersey which are annually producing large numbers of birds for the New York and Philadelphia markets. Undoubtedly many more of the poultrymen in this State could profitably raise capons each year. It offers an avenue through which surplus cockerels of the heavier breeds can be profitably prepared for the market.

In order to study the factors which are essential in the economical and profitable production of capons, the department has determined to carry on during the coming year some rather extensive, but very practical experiments in capon production. The first series will probably consist of studies in the rearing and feeding of Barred Plymouth Rock capons. It is planned to raise approximately 150 of these capons along strictly commercial lines. The present high values of foodstuffs and the indications of high prices during another year will make this experiment particularly valuable. In connection with this work a pen of White Plymouth Rock hens will be crossed with a typical White Cornish male, the male chicks from which will be caponized, reared, and managed under the same conditions as the Barred Plymouth Rocks. The main object of this cross will be to study the inheritance of meat-producing qualities.

Accurate figures will be kept as to the amount and cost of food consumption. An attempt will be made to seek the most profitable market at such seasons as the birds may be ready to sell.

3. Parcel Post Shipments of Eggs.—With the increase of interest in poultry production during the past few years, there have appeared upon the market several containers which are offered for use in the shipment of eggs by express or parcel post. During the past year there has been a popular inquiry on the part of many poultry raisers as to the efficiency of many of these well-

known packages or containers. The poultryman is interested in finding a box which will carry eggs safely when sent by either mode of transportation. This is particularly important during the spring season when many poultrymen are filling orders for comparatively small numbers of valuable hatching eggs.

In order to be efficient as a carrier for eggs, a package should have at least the following characteristics:

1. Rigid construction. It is essential that the material from which the containers are made should be capable of withstanding the rough usage to which they are liable to be subjected en route. It is equally essential that the boxes should be so constructed as to hold together firmly and serve as ample protection for the eggs.

2. The weight of such containers or carriers should be as light as possible, without, however, gaining that quality at the loss of security. The cost of sending these carriers by either mode of transportation is a great factor, which is of a very practical interest to the poultry producer.

3. All packages should be so arranged on the interior as to hold the eggs in perfect position and in separate compartments.

4. Every package used for this purpose should be carefully and conspicuously labelled.

During the summer 7 well-known makes of parcel post containers were presented to the department for testing purposes. The following is a list of the boxes used, together with the names and addresses of the manufacturers:

A. Made by Associated Farms Co., 314 West 53d St., New York.
B. Made by National Egg and Parcel Post Containers Association, 16 Court St., Brooklyn, N. Y.
C. The Wright Box, made by the Tywacanna Farms, Farmingdale, L. I.
D. Made by the U. S. Safety Egg Carrier Co., Inc., Newark, N. J.
E. Safe-Eg-Pak, made by Star Egg Carrier and Tray Mfg. Co., Minneapolis, Minnesota.
F. Surety Cushion, made by Surety Egg Box Co., Hohokus, N. J.
G. Diamond Box, made by Diamond Box Mfg. Co., Minneapolis, Minnesota.

The general scheme of the experiment was to send one of each of these types at hand to each of 5 different destinations. The same sized box was used in all shipments, namely, that holding two dozen eggs. The following parties received the packages and reported in detail upon the condition in which the packages arrived, breakage and general efficiency of each:

Carroll H. Hoagland, Ledgewood, N. J.; O. C. Luhrs, Toms River, N. J.; Miss F. R. Lewis, Exeter, R. I.; H. R. Drescher, Madison, Wisconsin; R. G. Fleming, Blackfoot, Idaho.

The general analysis of results pointed out very clearly to the observer that all of the packages examined would carry eggs safely either by parcel post or express, if they were not subjected to too severe handling and treatment en route. Undoubtedly methods of handling in transit are responsible for the greater percentage of loss sustained in the shipment of eggs.

4. THE SEASON'S EGG PRICES ON THE NEW YORK MARKET.—A study of the prevailing prices paid for strictly fresh eggs produced nearby, at our largest consuming center, New York City, shows that the price of this commodity is affected largely by the prevailing prices for other foodstuffs. The prices which the poultryman has received for eggs during the past year have been high, and the prospects are that they will reach a new high level. On November 1, 1916, strictly fresh white eggs in New York City were selling for 65 cents a dozen, and it seems to be a general belief among both shippers and receivers that the high prices of feed, together with the decreased number of birds kept, caused in large part by the rise in feed prices, will result in a continued shortage of eggs which will possibly result in eggs selling in New York by the first of the year at as high as $1.00 a dozen. This department during the past year has kept accurate records and plotted curves of price fluctuations, observing daily the possible causes of such variations. It seems safe to say that at no time have the financial possibilities from the raising of market poultry and eggs seemed more promising. It is true that the price of feed is on the incline, and certain standard feeds seem prohibitive in price, yet if this is accompanied by a more careful selection of the producing flock resulting in the feeding of fewer but better birds, and the paying of more attention to the quality of eggs and care in marketing, the present high price of eggs more than offsets the increased cost of production.

5. COMPARISON OF COMMERCIAL POSSIBILITIES OF CERTAIN VARIETIES OF DUCKS.—The duck raising industry is an important part of the whole poultry business. In order to obtain data on the commercial possibilities of certain varieties of ducks, an experiment is planned for the coming year in which such studies will be made of the White Brazilian, Pekin, and White Runner breeds, these being available at the present time. Accurate records will be kept of the food consumption, its cost, egg production, and other important data connected with the handling

of ducks under practical, commercial systems of management. Particular interest will be centered in the egg production of the White Runner Ducks, as they are noted for that particular characteristic. The market values of the other two breeds will hold the center of interest in the work with them. It is desired to make, along with this study, a detailed study of market conditions as related to the duck industry.

III

THE PRACTICAL USE AND APPLICATION OF POULTRY INVESTIGATIONAL WORK

Of great interest to the poultry producer in New Jersey is the use which is made of the above experimental problems and their possible application on his own plant. The following statements will give some idea of the methods and extent to which this department is attempting to disseminate and make applicable these results. The extension specialist in poultry husbandry is devoting his entire time to the dissemination of this information through the medium of lectures, demonstrations, projects, etc., this work being done in coöperation with the county farm demonstrators. A detailed report of these extension activities will be found in a separate part of the annual report of the Experiment Station. This work done by the extension specialist is in addition to the similar work performed by department members listed here. During the past year the correspondence of the department has maintained its same high figure; 7,510 letters have been written by the various members of the department in answer to requests for information and in the administration of the department. The majority of these were original dictated letters, and, in addition to this number, many hundreds of form letters were sent out covering special lines of activities.

During the past year much of the practical application of the research work has been brought about through conferences with the producers in the State. These conferences, many of which have been carried on at the Station, and many on the farms of the poultrymen, have been done entirely at the request of the poultrymen benefiting.

During the year 500 visits were made by poultry producers to the department in request of information. In giving this information a personal study of particular problems on the place being discussed are made and these are supplemented by literature covering the principles applied, which largely related to housing, breeding, feeding, and diseases. The great majority of the conferences at farms have covered the question of disease prevention and the location and laying out of plants and buildings.

As usual, numerous lectures have been given throughout the State by members of the department. The poultry husbandman gave 61 such lectures, the majority of them being illustrated with either lantern slides or charts; 36 lectures have been given by other members of the department other than the extension specialist, making a total of approximately 100 lectures delivered during the year, the majority of these before local poultry associations, housewives' leagues, and farmers' institutes.

A considerable number of demonstrations have been given during the year, although, where possible, this work has been left or turned over entirely to county demonstrators and to the extension specialist. Numerous requests, however, have come in for demonstrations on disease diagnoses, and caponizing, so many, in fact, that it was necessary for members of the research department to coöperate by giving a considerable number along these two specific lines.

As in the past, the Poultry Department has maintained an extensive poultry exhibit. During the part year this exhibit was made much more permanent, and while fewer shows were visited, it is believed that through its permanence and increased attractiveness, much more has been accomplished than heretofore. In staging this exhibit, the effort has been to consolidate on only a few of the many poultry problems, especially housing, feeding, breeding, and marketing. During the year this educational exhibit was staged at the following functions—the show of the New Jersey State Poultry Association at Dover; the annual show of the Union County Poultry Association at Elizabeth; the Empire State Poultry Show at the Grand Central Palace, New York City; the Madison Square Garden Poultry Show at New York City; the Monmouth County Fair, and the Trenton Fair.

At intervals during the year, portions of the exhibit have been loaned to county demonstrators for special occasions.

In connection with the staging of the poultry exhibit, it has been customary, as in the past, for the poultry husbandman to judge market poultry and commercial egg classes. During the past year such classes were judged at the Allentown Fair, the Trenton Fair, and the Mount Holly Fair, and the Elizabeth and Dover Poultry Shows. An especially attractive exhibit of utility poultry and market eggs was staged at the Allentown Fair.

During the year the regular "Hints to Poultrymen" have been published each month, and, as usual, have been found invaluable in maintaining interest in poultry organizations, and have been found especially valuable as a means of more fully answering correspondence, and providing a record of suggestions at

conferences. The following is a list of the "Hints to Poultrymen" published during last year:

October—Keeping the Poultry Flock Healthy.
November—Coöperative Buying of Poultry Feeds.
December—Litters for the Poultry House.
January—The February-Hatched Pullets.
February—Artificial Incubation.
March—Home Preservation of Eggs.
April—Producing Market Eggs of High Quality.
May—Disposing of Surplus Cockerels.
June—How to Get a Poultry Education.
July—Green Crops for the Poultry Yard.
August—Standard Unit Poultry Houses.
September—Balancing the Poultry Flock.

During the year the members of the research department have contributed regularly each week to the news letter published by the extension division of the State Agricultural College.

Aid to local poultry associations in the State has continued to be a feature of the department's work. At the present time the majority of these organizations are firmly established, carrying on valuable educational programs and coöperating with the research department in conducting many of these investigational problems, especially those pertaining to poultry farm management, and the standardization of poultry equipment. It is hoped that all persons in the various communities of the State interested in poultry husbandry will ally themselves with one or more of these county organizations. The following is a list of these organizations and their executive officers serving at this writing:

Atlantic County Mutual—Mr. Henry Tapken, Egg Harbor, N. J.

Atlantic County Poultry Association—Mr. John P. Dorland, Linwood, N. J.

Poultry Raisers' Association of Hammonton—Mr. Benj. Lackey, Hammonton, N. J.

Bergen County Poultry Association—Mr. C. Crane, Hackensack, N. J.

Glen Rock Poultry, Pigeon and Pet Stock Association—Mr. J. W. Wolf, Glen Rock, N. J.

Northern Valley Poultry Association—Mr. A. B. Blardsell, Bergenfield, N. J.

Palisades Poultry Association—Mr. Walter Spink, Coytesville, N. J.

Millville Poultry Association—Mr. Harry W. Shaw, Millville, N. J.

Vineland Poultry and Pet Stock Association—Mr. H. S. Tuthill, Vineland, N. J.

Essex County Poultry Association, Inc.—Mr. Russell Jacobes, 104 Alexander Ave., Montclair, N. J.

Greater Newark Poultry and Pigeon Association, Inc.—Mr. J. L. Adams, 102 Union Ave., Irvington, N. J.

Gloucester County Poultry Association—Mr. Wm. W. Rehr, Woodbury, N. J.

GLASSBORO POULTRY AND PET STOCK ASSOCIATION—Mr. R. S. Doughey, Glassboro, N. J.

MERCER COUNTY POULTRY ASSOCIATION—Mr. C. B. Landes, 107 Park Place, Trenton, N. J.

MIDDLESEX COUNTY POULTRY ASSOCIATION—Mr. S. F. Zimmerman, New Brunswick, N. J.

BELMAR POULTRY ASSOCIATION—Mr. Philip Schmitt, Como, N. J.

MANASQUAN POULTRY ASSOCIATION—Mr. T. J. Woodfield, Manasquan, N. J.

MONMOUTH COUNTY POULTRY ASSOCIATION—Mr. G. W. Blatchley, Freehold, N. J.

MONMOUTH POULTRY CLUB—Mr. John Yeomans, Oceanic, N. J.

DOVER POULTRY, PIGEON AND PET STOCK ASSOCIATION—Mr. H. K. Caldwell, Dover, N. J.

MORRISTOWN POULTRY, PIGEON AND PET STOCK ASSOCIATION—Mr. Stuart R. Whitenack, 3 High St., Morristown, N. J.

OCEAN COUNTY POULTRY ASSOCIATION—Mr. Owen B. Shute, Toms River, N. J.

PATERSON POULTRY ASSOCIATION, INC.—Dr. Gilbert Johnston, 210 Market St., Paterson, N. J.

PASSAIC POULTRY, PIGEON AND PET STOCK ASSOCIATION—Mr. W. L. Hundertmark, 157 Main Ave., Passaic, N. J.

NORTH JERSEY POULTRY ASSOCIATION—Mr. J. S. Roe, Newton, N. J.

LAKEWOOD POULTRY ASSOCIATION—Mr. H. Douglass Rhodes, Lakewood, N. J.

UNION COUNTY POULTRY ASSOCIATION—Mr. A. J. Churchill, Elizabeth, N. J.

SOUTH JERSEY POULTRY ASSOCIATION—Mr. L. G. Heller, Bridgeton, N. J.

HUDSON COUNTY POULTRY ASSOCIATION—Mr. Joseph Groben, 32 West 24th St., Bayonne, N. J.

EASTON POULTRY ASSOCIATION—Mr. W. F. Bast, 14 Marshall St., Phillipsburg, N. J.

WASHINGTON POULTRY ASSOCIATION—Mr. Wm. Cyphers, Washington, N. J.

In conclusion, it might be said that in so far as a practical application of the investigational work may be concerned, it is the policy of the department to divert as much of these activities as possible to the extension specialist, but it seems to be very evident from the nature and extended calls upon the research department that it will never be possible entirely to divorce these lines of activity.

IV

VINELAND EGG LAYING AND BREEDING CONTEST

Probably the most notable addition to the work of the department during the past year has been the inauguration of the Vineland International Egg Laying and Breeding Contest.

At last New Jersey has an egg laying contest all its own: a contest that is unique in that in addition to the egg laying features, there is included the breeding feature and the progeny test. During the past five years, 1-year contests have attained

much popularity in America. These contests have taught and brought to the attention of the poultryman the fact that his birds differ exceedingly in their ability to produce. These contests have also been of extreme advertising value to the contestants. Our New Jersey Contest will, it is believed, be many times more valuable to our New Jersey poultrymen because it continues for a 3-year period, includes breeding, as well as egg laying, and also because arrangements are made whereby the contestants themselves can reap a great benefit through securing surplus hatching eggs and pedigreed birds raised at the Contest.

FINANCIAL SUPPORT.—Our New Jersey Contest has been made possible through the substantial financial support from a number of different sources. First, the business interests of Vineland, spurred on by activities of the Vineland Poultry Association, secured an appropriation of $8,000.00 from Vineland and vicinity, which funds have been used to construct the buildings and fences. Over 8 acres of land, nearly level, but with a slight southerly slope, extraordinarily well adapted to the purpose of the Contest, were loaned for the purpose by the Vineland Training School. It can be truly said that no contest has or could expect to have a more ideal location with reference to area and contour of land, type of soil, and climatic conditions than the International Egg Laying and Breeding Contest at Vineland.

The Legislature of the State of New Jersey in its last session appropriated $9,000.00 to go toward defraying the expenses of the Contest, $3,000.00 to be given yearly for three years. This fund will be used exclusively for the payment of salaries, all men in charge of the Contest being experienced poultrymen who have successfully practiced for themselves and others, and who are regularly appointed on the competitive civil service list of the State of New Jersey. In addition to the appropriation mentioned, the funds received from the entry fees and the income from the Contest will, it is expected, adequately provide for the maintenance thereof. Our Contest then, is supported by the taxpayers of New Jersey through acts of their Legislature, and not by private interests. It, therefore, behooves everyone interested in poultry in the State to get the benefit from the Contest by studying the records carefully, visiting the contest plant when possible, and applying the lessons learned from the Contest in the management of their own poultry operations.

OBJECTS OF THE VINELAND CONTEST. —The objects of our Contest are many and varied. Probably the primary object lies in giving greater attention to egg production and the methods of breeding for this characteristic, for it is only in this way that the greatest usefulness in all of our varieties can be developed. This does not mean that any less attention should be given to the breeding of standard-bred birds or to their exhibition, nor should this be antagonistic in any way to any other form of poultry endeavor, but, on the contrary, this study and attention to essential utilitarian characters should result in greater interest, greater enthusiasm, and better financial returns along all lines.

The second object of the Contest is to furnisb a means which shall be accurate and authentic whereby the poultryman can demonstrate his ability to breed for high egg production. It is but fair that extreme ability in this line should receive the same recognition as the ability of the fancier to breed exhibition birds. The Egg Laying and Breeding Contest will allow every poultryman to determine and show his mastery of this additional feature of poultry breeding, just as the breeder of exhibition specimens can demonstrate his attainments by competing in the show room.

A third valuable object of the Contest is that it will provide ample means for securing valuable data bearing on the mode of inheritance of egg production. The often disputed question of the relative value of the male and female in getting high-producing pullets can be studied. The relative value of high *versus* low-producing hens as breeders of future generations of pullets can be studied in considerable detail.

A fourth object to be shown forcibly to the poultry-producing public lies in the fact that hens differ very materially in the producion. The Contest will also call attention to the fact that the non-productive, and hence unprofitable birds, must be weeded out if the greatest profit is to be realized from the flock. This Contest should serve the poultry interests of the State in the same manner as the cow testing association serves the dairy interests.

Another object, and by no means the least, is to collect the great volume of data which can be secured bearing on external characters, which may or may not be capable of correlation with egg production. If, by careful study, it can be found, as has already been pointed out by similar work at other stations, that shank color, beak color, ear lobe color, vent color, etc., together with many other external visual characters which will be studied, can be

correlated with egg production, the problem of the commercial poultrymen in weeding out his non-productive birds will be materally simplified.

Another object lies in the fact that this Contest, conducted with extreme accuracy, all records being unquestionable, will provide valuable information on the amount, cost, and duration of egg production, factors which are vital to the control of any commercial egg farm.

Another important object of the Contest lies in the possibility of returning to the owner of the original birds entered, not only a detailed pedigreed trap-nest record of the original birds for two years, but also the same record for a limited number of their daughters. In addition, of even more importance, during the progress of the Contest, the owner can secure pedigree hatching eggs, young chicks, and surplus cockerels and pullets, which can be used immediately in the establishment of improved lines of commercial breeding on his farm.

Lastly, it is appreciated that this Contest will have exceptional advertising advantages to all contestants. The results of the Contest will be given wide publicity. The contestants will be recognized as among the best breeders of their respective varieties in this country. Those whose pens make an exceptional showing, either in regard to production or breeding qualities, will receive advertising advantages which money cannot buy.

In conclusion, it might be said that the Contest is run primarily for the gaining of knowledge which, when applied commercially, will make a more profitable poultry industry.

Rules and Regulations

1. This Contest shall be known as the Vineland International Egg Laying and Breeding Contest, conducted by the New Jersey Agricultural Experiment Station at Vineland, N. J. The Contest will begin November 1, 1916, and extend for a period of three years, ending October 31, 1919.

2. The Poultry Department of the Agricultural Experiment Station will have entire charge of the Contest. None but those in the regular employ of the Experiment Station will be allowed to carry on the Contest. The superintendent and foreman will be regular members of the poultry staff of the Agricultural Experiment Station. All records, including eggs laid, weight of eggs, amount fed, duration of molt, frequency of broody periods, etc., will become a part of the regular records of the Experiment Station. These data, together with all other data, will be published, from time to time in the regular reports and bulletins of that institution. These facts are a sufficient guarantee of the honesty and fairness of the Contest.

3. Each entry will consist of a pen of 10 pure-bred pullets; the male bird being supplied by the owner March 1, 1918. The pullets entered must

be hatched during the dates of January 1, 1916, and July 1, 1916. The date on which the pullets were hatched must be given in order to add to the experimental data.

4. The Contest shall continue for a period of three years.

5. The plan of the Contest shall be to trap-nest the ten pullets in each pen competing for the year 1916–1917, and the year 1917–1918, the latter year being their yearling or second year production. During March, April and May of 1918 these hens will be mated to a male bird furnished by the owner, and 100 eggs from each pen will be hatched in a mammoth incubator, and, as far as possible, 10 eggs from each hen will be incubated and hatched. The chicks will be brooded in colony brooder stoves. From these birds so hatched, 10 pullets, one from each hen in so far as possible, will be selected in the fall of 1918 and from November 1, 1918, to October 31, 1919, these pullets will be placed in the pens occupied by their parents, and will be trap-nested during the interim. The original pen will be returned to the owner November 1, 1918.

6. Competition is open to all poultry raisers throughout the world.

7. Only pure-bred birds of a recognized standard breed will be accepted for competition. The management reserves the privilege to refuse any entry in which birds show signs of disease, or which for any reason are unsuited to the aims and purposes of the Contest.

The management also reserves the right and power to bar from competition any pens which show evidence of cross-breeding and to refuse entries, the acceptance of which will prevent a fair representation of a great majority of standard breeds. It is the aim of the management to secure pens of as many representative varieties as possible, rather than to secure a great many pens of one variety.

8. Uniform care will be given to all pens, and feeding and management will be in the hands of experts. Special attention will be given to sanitation and disease prevention and every means will be taken to get from the pens the maximum production.

9. The management holds itself in no way responsible for loss by fire, disease, vices, or unavoidable accidents. While every precaution will be taken to prevent the occurrence of such happenings, no official of the Contest will be held responsible should such a loss occur.

1. No reserve birds will be required or accepted and held subject to the loss of any birds in a given pen, but the owner, however, is requested to have in readiness reserve birds which can be immediately shipped upon notification of the need of such a bird in any pen. The management will be immediately notified by writing. Reserve birds will be allowed in case of infection, disease or death, permanent injury due to accident or the development of vices, such as egg-eating, feather-pulling, etc. In other words, the owner will be given the privilege of maintaining the full number of 10 birds in the competing pen throughout the duration of the Contest.

11. The management reserves the right to slaughter any bird or birds, the presence of which, due to disease or other cause, would be detrimental to the success of the Contest.

12. The Contest shall consist of 100 pens of 10 birds each.

13. The management reserves the right to clip the feathers of one wing of any bird in the Contest which shows a tendency to fly from the yards persistently.

14. The Contest shall be decided by the total number of marketable eggs laid by each pen. Exceedingly malformed eggs, soft-shelled eggs, or eggs weighing less than 18 ounces to the dozen, will not be considered.

15. In order to induce and secure competition between breeds, three applications for entry for one variety must be received before entries of that variety will be accepted.

16. The owner's name will appear on the monthly reports, together with the pen number. The owner's name, together with the variety, will be placed in a conspicuous position on each pen in the contest.

17. Special prizes of medals and cash will be awarded as outlined in a special premium list which is not yet available for publication.

18. An entry fee of $50.00 for each pen of 10 birds is charged for the three years, $10.00 to be paid upon the filing of the application, and the balance, or $40.00, to be paid not later than September 15, 1916. Failure to pay the balance of the entry fee when due forfeits the right to return of the application deposit.

19. All birds must be shipped prepaid to the Vineland International Egg Laying and Breeding Contest at Vineland, New Jersey, and must reach the Contest on or before October 20, 1916. This 10 days' rest is allowed in order that the birds may become accustomed to their new environment and get acclimated.

20. The decision of the management in regard to all details of the Contest shall be considered final and no appeal in any form will be considered or allowed.

21. The owner of each pen must provide a breeding male during the spring of 1918. This bird must he shipped prepared to arrive at the Contest not later than February 15, 1918. In case the male bird is not fertile, the owner will be given the privilege of supplying an additional male bird. Upon the failure of the owner to provide a male bird of his own, the Experiment Station reserves the right to use a male of its own in such pens, in order that breeding records may be completed. It is urged that competitors plan now to breed males for use in the Contest at this time. Where possible it is urged that pedigreed males be provided, the pedigree being furnished to the management when the bird is shipped. Males will all be returned to owners by June 1, 1918. In any case where the Experiment Station exercises the right to provide a breeding male, due to failure of owner to provide, such pens are automatically debarred from all competition during the Contest.

22. No entry can be withdrawn at any time during the duration of the Contest.

23. All pens will be trap-nested during the entire three years of the Contest. The detailed trap-nest records will be presented to the contestant at the conclusion of the Contest. Weekly reports will be sent to each contestant, and complete monthly records will be prepared for publication in agricultural and poultry periodicals.

24. During March, April, and May, 1918, 100 eggs will be incubated from each pen, 10 eggs being set from each hen in so far as possible. The chicks will be brooded up to 15 weeks of age. All chicks will be pedigree-hatched and permanently banded. At the age of 15 weeks, 20 of the best pullets, two from each hen as far as possible, will be selected and reared to maturity. Ten from these 20 pullets, one from each hen, as far as possible, will be selected October 31, 1918, and placed in the pen occupied by their parents, November 1, 1918. The alternate yards will be used for the rearing of these pullets.

25. The yearling hens will be returned to the owner at the completion of their two years' work at the Contest. They will be returned November 1, 1918.

26. All vigorous and healthy cockerels and surplus pullets resulting from 100 eggs set during the spring of 1918 will be sold to the owner at the following rate: $1.00 for each bird, regardless of sex or age, all to be sold at 15 weeks of age, with the exception of certain pullets which will not be available until after the final pullet selection of the 10 for the last year's work. If not desired by the owner, these birds will be slaughtered on the premises and sold for meat.

27. All eggs produced become the property of the New Jersey Agricultural Experiment Station and will be sold on the wholesale markets. No fertile eggs will be produced except during the three months designated during the spring of 1918.

28. All hatching eggs produced during the spring of 1918 which are not required for Contest purposes will be sold to the owner at the rate of 10 cents each, or $10.00 per one hundred. If not desired for this purpose, they will be sold on the New York or Philadelphia wholesale markets for table purposes. No designating marks or numbers will be on the eggs when sold.

29. In the case of a pen of birds changing ownership during the progress of the Contest, the new owner shall be bound by the rules and regulations under which the pen was originally entered. In case of such change of ownership, the original, as well as the new name, shall be used in designating the pen.

30. All revenue received from the sale of products will be used to conduct the Contest. Any profit which may have accumulated at the conclusion of the Contest will be divided equally between the original contestants and will be refunded during the month of November, 1919.

31. All entries will be filed in order of their receipt and will be accepted according to provisions of these rules in that order.

Contest Management

As previously mentioned, the Contest plant occupies an area of 8 acres, nearly square. The houses are arranged in five rows of 20 houses each, with suitable roads and walks connecting them. The land occupied by the Contest is at present covered with an excellent alfalfa sod, and it is

planned to maintain this sod permanently. The competing birds will be cared for in 100 houses, facing south, each 8 by 10 feet, with shed roof construction, muslin and glass openings in the front, and double boarded at the back, with rear ventilation. Each house is supplied with the most modern interior equipment, including 5 trap-nests, brood coops, feeding appliances, etc.

It is recognized that the feeding problem is the most important. With this in view, the following regulations and rations have been adopted.

Rations have been evolved which carry a sufficient amount of nutrients properly proportioned for the object of the Contest. The rations have been made as simple as possible, and only the common grains of wheat, corn, and oats and certain of their by-products will be used. The dry mash method of feeding has been adopted to be supplemented by grains fed in deep litter. Grit, shell, and charcoal will be provided in separate hoppers and kept continually before the birds. All feeding will be in the hands of expert, practical men, who have had experience with both heavy and light breeds. Identical rations will be fed to all competing pens. Modifications necessary for different breeds will be made in the amount fed and in the method of feeding. In regulating the diets, the object will be to maintain the birds at a uniform standard weight. All individual birds will be recorded in weekly periods and a detailed study will be made of the relation of egg production and food consumption.

New Jersey Contest Marsh

100 lbs. wheat bran.
100 lbs. wheat middlings, white or flour.
100 lbs. ground oats, standard or better.
100 lbs. corn meal, pure.
100 lbs. meat scrap, 50 per cent protein.

The above dry mash contains considerable variety, the ingredients are readily obtained, and being in 100-pound quantities, can be readily mixed. This dry mash contains 18.2 per cent of protein and 39.9 per cent of carbohydrates. This makes the nutritive ratio for the mash 1 to 2.8.

Supplementing this dry mash, the competing fowls will be given morning and night deep litter, the following rations:

100 lbs. wheat.
100 lbs. cracked corn.
100 lbs. clipped oats.

This grain has a nutritive ratio of 1 to 8.2. The amount of this ration which is fed will be determined by the amount of mash consumed and the weight and production of flocks.

Contestants

The following is a list of the contestants and the breeds which they are entering. This list is given with the belief that persons located in different communities in the State will be especially interested in following the records made by pens from their own community. In this way a greater interest and a more complete application of the teachings of the Contest can be secured. Look the list over and get acquainted with those in your vicinity who have birds entered in the Contest, and follows the results along with them.

Pen.	*Owner and Address.*	*Breed.*
1.	Garret W. Buck, Colts Neck, N. J.,	Barred Plymouth Rocks
2.	Thomas Henry, Chester, Pa.,	" " "
3.	Otto C. Luhrs, Toms River, N. J.,	" " "
4.	C. N. Myers, Hanover, Pa.,	" " "
5.	Harry H. Ober, Lakewood, N. J.,	" " "
6.	Overlook Farm, New Brunswick, N. J.,	" " "
7.	George O. Ward, Kennebunk, Maine,	" " "
8.	Woodside Farm, Exeter, R. I.,	" " "
9.	Chester P. Dodge, Rockport, Mass.,	White Plymouth Rocks
10.	Holliston Hill Poultry Farm, Holliston, Mass.,	" " "
11.	Edward E. Murray, Pine Bush, N. Y.,	" " "
12.	Victor S. Reichenbach, Lansdale, Pa.,	" " "
13.	Overlook Farm, New Brunswick, N. J.,	" " "
14.	Wilburtha Poulthy Farm, Trenton Junction, N. J.,	" " "
15.	Deptford Poultry Farm, Sewell, N. J.,	Columbian Plymouth Rocks
16.	T. J. Enslin, Hackettstown, N. J.,	" " "
17.	J. M. Jones, Hornerstown, N. J.,	" " "
18.	Thomas Coates, Monmouth Junction, N. J.,	White Wyandottes
19.	A. H. Faulkner, Millington, N. J.,	" "
20.	Thomas Henry, Chester, Pa.,	" "
21.	Gablewood Poultry Farm, Hammonton, N. J.,	" "
22.	Luscroft Farm, Sussex, N. J.,	" "
23.	E. C. Moore, Maplewood, N. J.,	" "
24.	T. H. Matteson & Son, Davisville, R. I.,	" "
25.	Sunnybrook Farm, Eatontown, N. J.,	" "
26.	H. S. Tuthill, Vineland, N. J.,	" "
27.	Lake Farm, Slocum, R. I.,	Columbian Wyandottes
28.	Sunnybrook Farm, Eatontown, N. J.,	" "
29.	Wilburtha Poultry Farm, Trenton Junction, N. J.,	" "
30.	Clark & Howland, West Paulet, Vt.,	Buff Wyandottes
31.	W. P. Laing, Woodbury Heights, N. J.,	" "
32.	Mrs. C. B. Elliott, Menlo Park, N. J.,	" "
33.	Belle Ellen Stock Farm, Sussex, N. J.,	S. C. R. I. Reds
34.	H. W. Collingwood, Woodcliffe Lake, N. J.,	" " "
35.	Thomas H. Dawson, Scottdale, Pa.,	" " "
36.	Etjon Poultry Farm, South Vineland, N. J.,	" " "
37.	Thomas Henry, Chester, Pa.,	" " "
38.	Miss Adeline S. MacIntoch, Princeton, N. J.,	" " "
39.	Underhill Bros., Lakewood, N. J.,	" " "
40.	Woodland Poultry Yard, Wyncote, Pa.,	" " "
41.	Avalon Farms, Westport, Conn.,	S. C. White Leghorns
42.	E. A. Ballard, Chestnut Hill, Pa.,	" " "
43.	Will Barron, Bartle, near Preston, England,	" " "
44.	Belle Ellen Stock Farm, Sussex, N. J.,	" " "
45.	Broad Brook Farm, Bedford Hills, N. J.,	" " "
46.	Coverlawn Farm, South Vineland, N. J.,	" " "
47.	W. J. Cocking, Vineland, N. J.,	" " "
48.	Joseph H. Cohen, Woodbine, N. J.,	" " "
49.	J. S. Cray & Son, Stockton, N. J.,	" " "
50.	Charles Daval, Jr., Vineland, N. J.,	" " "

51.	L. S. and N. L. Depue, Layton, N. J.,	"	"	"
52.	R. F. and R. A. Earle, Bloomfield, N. J.,	"	"	"
53.	Harry G. Gardiner, Millville, N. J.,	"	"	"
54.	C. S. Greene, Lakewood, N. J.,	"	"	"
55.	Airedale Farm, West Hartford, Conn.,	"	"	"
56.	B. Frank Grunzig, Westfield, N. J.,	"	"	"
57.	Henry E. Heine, Lakewood, N. J.,	"	"	"
58.	Richard Heine, Lakewood, N. J.,	"	"	"
59.	Heigl's Poultry Farm, Rocky River, Ohio,	"	"	"
60.	Hilltop Poultry Yards, Suffield, Conn.,	"	"	"
61.	Hillview Farm, Lincoln, Mo.,	"	"	"
62.	Holliston Hill Poultry Farm, Holliston, Mass.,	"	"	"
63.	Hugh J. Hoehlm, Brooklyn, N. Y.,	"	"	"
64.	James F. Harrington, Hammonton, N. J.,	"	"	"
65.	John R. Lauder, Vineland, N. J.,	"	"	"
66.	Laywell Poultry Farm, Plainville, Conn.,	"	"	"
67.	Fred J. Mathews, Lambertville, N. J.,	"	"	"
68.	Mercer Poultry Farm, Trenton, N. J.,	"	"	"
69.	Merrythought Farm, Columbia, Conn.,	"	"	"
70.	H. H. Myers, Vineland, N. J.,	"	"	"
71.	Samuel Niece & Son, Stockton, N. J.,	"	"	"
72.	Oak Hill Estate, Uniontown, N. J.,	"	"	"
73.	Thomas Henry, Chester, Pa.,	"	"	"
74.	Oakland Farm, Trenton Junction, N. J.,	"	"	"
75.	Miss Anna C. Parry, Wyncote, Pa.,	"	"	"
76.	P. G. Platt, Wallingford, N. J.,	"	"	"
77.	Riverside Egg Farm, Milton-on-Hudson, N. Y.,	"	"	"
78.	Joseph H. Ralston, Vineland, N. J.,	"	"	"
79.	Shadowbrook Farm, Ridgefield, Conn.,	"	"	"
80.	Sloan's Egg Farm, Flemington, N. J.,	"	"	"
81.	Pinehurst Poultry Farm, Gwynedd Valley, Pa.,	"	"	"
82.	Herman F. Sonder, Toms River, N. J.,	"	"	"
83.	A. E. Spear, Vineland, N. J.,	"	"	"
84.	Sunnybrook Farm, Eatontown, N. J.,	"	"	"
85.	Tenacre Poultry Farm, Princeton, N. J.,	"	"	"
86.	Toms Poultry Farm, Toms River, N. J.,	"	"	"
87.	Training School, Vineland, N. J.,	"	"	"
88.	J. Percy Van Zandt, Blawenburg, N. J.,	"	"	"
89.	Shurts and Voetlen, Lebanon, N. J.,	"	"	"
90.	Gustav Walters, Vineland, N. J.,	"	"	"
91.	White House Poultry Farm, Hammonton, N. J.,	"	"	"
92.	W. K. Wixon, Germantown, Pa.,	"	"	"
93.	Willanna Farm, Unionville, N. J.,	"	"	"
94.	Woodland Farms, Butler, N. J.,	"	"	"
95.	H. G. Richardson, Etra, N. J.,	S. C.	Buff	Leghorns
96.	Romy Singer, Morganville, N. J.,	"	"	"
97.	Monmouth Farms, Freneau, N. J.,	"	"	"
98.	A. E. Hampton, Pittstown, N. J.,	S. C.	Black	Leghorns
99.	Fred C. Nixon, Quakertown, N. J.,	"	"	"
100.	Sunny Acres, Trenton, N. J.,	"	"	"

Advantages and Possibilities

There are many ways in which poultry keepers of New Jersey can benefit from the Contest whether contestants or not. First, follow the progress of the Contest from week to week, getting acquainted with the individual birds and their performance. Second, this interest in the Contest will no doubt create an interest in personal record keeping at home. Communicate with the Experiment Station and learn how it is possible for you to carry on coöperative record keeping with the Poultry Department through the county farm demonstrator. Third, visit the Contest plant at frequent intervals and study in detail the methods which are being used, with the hope of applying them to one's home flock. Fourth, be sure that your name is placed on the mailing list for all free publications pertaining to the Contest.

Weekly Report Sheet

Weekly and monthly report sheets will be regularly published throughout the duration of the Contest. These sheets will show the individual egg production of each bird for the week, the total production of each bird for the week, and the total production for each pen during the same period. These data will be published extensively in agricultural periodicals, newspapers, etc., where it can be secured and studied regularly at no cost. This publication will also be sent free of charge to all contestants. All others wishing to secure an official copy for study will be placed on a regular subscription list at the payment of $1.00 per year. This amount hardly covers the cost of printing, addressing and mailing such a bulletin. Should you wish to subscribe for this publication, notify the Poultry Department immediately in order that your subscription may begin with the first issue. Remember that the Egg Laying and Breeding Contest is being run for you. Do not hesitate to take advantage of it and write us if there is anything which we can do for you, or any facts which we can give you regarding its progress.

V

Conclusions

In conclusion, it might be said that the outlook for the future is very promising. The new poultry farm will be completed during the next year, which, after its completion, will admit of greater attention to research activities and will admit of following in greater detail the progress of these activities.

This plant, completed, will give us a ideal equipment for the work at hand. With the Vineland Contest under way and giving us weekly valuable data for study, much interest should be secured from this source. There has been, during the past year, considerable demand from the turkey interests of the State for some work to be done in rearing and feeding turkeys at the Station. If funds can be found with which to do this work, it is hoped that in view of the fact that adequate land is available, some turkey work can be started during the coming year.

It is with pleasure that the poultry husbandman has been able to report progress on the many lines of effort which have been pursued for some years, and it is with extreme gratification that the various new branches of work herein outlined have been so successfully started.

REPORT OF THE DEPARTMENT OF DAIRY HUSBANDRY

Department of Dairy Husbandry

William J. Carson, B.S., *Dairy Husbandman.*
Lloyd S. Riford, A.M., *Assistant Dairy Husbandman.*

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Report of the Department of Dairy Husbandry

WILLIAM J. CARSON

I
INTRODUCTION

The work of the Department of Dairy Husbandry for the fiscal year just closed has been practically a continuation of that of the previous year. This naturally divides itself as follows:

1. *Investigational Work*—Including relation of conformation of heifers to future production, and the value of alfalfa hay and corn meal as a ration for dairy cows.
2. *The Herd*—Covering a full record of the average production of each animal in the herd, the cost of production, data concerning the cost of raising heifers and calves, and changes in the herd.
3. *Cow Testing Association*—Which includes records of production and feed cost from about 1,000 cows.
4. *Advanced Registry Work.*
5. *Testers' License, and Babcock Test Glassware Regulations.*

Needs of the Department

The department is in need of suitable bull paddocks in order that these animals may be given proper exercise. For want of better accommodation the bulls are now being kept tied in stalls commanding a clear view of the rest of the herd. As a result, the bulls are in a nervous condition and are without any form of exercise throughout the year. This is not the kind of treatment we would recommend, nor is it most conducive to the building up and maintaining of health and vitality in this class of animals.

If the work of building up a pure-bred herd at this Station is to be continued, more suitable accommodation for the housing of the young stock will be necessary. At the present time the young stock is being housed in a shed intended for the storage of machinery. This is a cement building without proper ventilation. It is cold, draughty and entirely unsuited for the purpose for which it is being used. Young stock must be kept dry, warm and in a thrifty condition if the best results are to be obtained.

II

INVESTIGATIONAL WORK

Relation of Conformation of Heifers to Future Production

The department has under way an extensive investigational project having as its object the determination of the relation of certain physical characteristics in dairy heifers to the future production of these heifers. This Station is unusually well situated for work on this problem since it is possible to secure data on a large number of animals, both as calves and heifers and later as producing animals. The kindness of two large producing concerns has made available their animals for the work. Data are being secured from these two herds in which about 250 heifer calves are raised annually. The animals in the Station herd are used and it is planned to include several well-known pure-bred herds.

Weights and certain body measurements are taken and observations made monthly on these heifers until they are 2 years of age. The relation of these measurements to the productive ability of the animals will be determined after the production records of the first lactation period are available. For a greater part of the heifers used, accurate records of production of the dams will be available. The relation between the conformation of the dam and the heifer will be determined with a large number. Data are being secured regarding the sires of practically all the heifers, and it is expected that the relation of certain physical characteristics of the sire to the conformation and productive ability of his daughters will be conclusively demonstrated.

The experiment will involve several years' work and no study can be made of the data until complete records of the animals have been secured. Complete data on five hundred animals should be available after four or five years.

Corn and Alfalfa—Feeding Trial

A feeding trial was conducted at the Station to compare a ration of corn and alfalfa with a ration of hay, silage, beet pulp and a mixture of purchased concentrates. This trial was conducted as the first step in work to determine the best means of including in the ration the greatest possible amounts of alfalfa hay and corn, either as silage or grain. Further work will involve feeding trials with varying amounts of hay, corn

and silage and also work with heifers to determine whether they can be wintered on alfalfa and corn or corn silage alone to an advantage.

Eight cows were used in the trial through two periods of 30 days each. The cows were in two lots and were alternated after an intermediate period for change of ration. The grain mixture fed the cows on the regular or mixed ration was as follows:

Corn meal, 300 lbs.; hominy, 300 lbs.; distillers' grains, 200 lbs.; brewers' grains, 100 lbs.; bran, 100 lbs.; Buffalo gluten, 100 lbs.; cottonseed meal, 50 lbs.; linseed oil meal, 50 lbs.

A brief summary of the results is given below. The table shows the average daily consumption of the 8 cows for the 30 days they were on each ration and the average daily production of milk.

DAILY AVERAGE.	*Mixed Ration.*	*Alfalfa and Corn Meal.*
Alfalfa hay,	9.16	23.17
Corn meal,		7.63
Silage,	27.43	
Beet pulp,	4.00	
Grain mixture,	6.69	
Milk produced,	27.52	25.30
Weight (at end of test),	988.00	982.00

It is evident that the cows did not maintain their production on a ration of alfalfa and corn alone. The decrease in production amounted to 8.1 per cent. This is not a marked decrease when the variety and efficiency of the regular ration is considered. Calculating alfalfa and corn at cost of production, $10 and $25 per ton, respectively, the corn and alfalfa ration was 19.8 per cent cheaper.

The cows readily consumed sufficient amounts of the ration to furnish the necessary protein and energy. One Holstein cow, weighing 1,200 pounds, consumed 25 pounds of hay and 15 pounds of corn meal daily and averaged 41.8 pounds of milk.

Feeding for longer periods will be necessary before drawing any definite conclusions as to the possibility of such a ration. A similar experiment, previously reported,[1] covering 10 weeks,

[1]Hoard's Dairyman, Feb. 25, 1916.

indicated that production could be maintained equally as well as on a mixed ration. Work along these lines will be continued.

III

THE DAIRY HERD

An inventory, taken at the close of the year, shows the herd to consist of 75 head, representing five breeds, namely: Holsteins, 44; Jerseys, 19; Guernseys, 5; Ayrshires, 5; and grade Short-Horns, 2. The Holsteins include 32 grade and 12 pure-bred animals; all the Jerseys and Ayrshires are pure-bred and four of the Guernseys are pure-bred, the other being a grade heifer. As to the quality of the animals in the herd, it may be said that the Holsteins and Jerseys are fairly representative of the breeds. The Guernsey and Ayrshire females are poor individuals and the department is badly in need of a half-dozen or so of real good females of each of the latter breeds which may be used for judging purposes in the classroom. During the year there have been several changes made in the herd. Some of the animals were unproductive, others again failed to breed and were sold. In all, 18 head were disposed of and 12 others purchased. Of the number purchased 4 were young pure-bred animals of superior breeding which, in time, should be the means of improving the herd to some extent. Leaving out the cost of the four animals mentioned, the sales of stock for the year have exceeded the purchases by over $500.

The Summary, 1916

		Number.	Value.
Holsteins—			
(Pure-bred)	Bulls,	2	$400 00
	Cows,	4	650 00
	Heifers,	6	450 00
(Grades)	Cows,	24	2,805 00
	Heifers,	8	500 00
Jerseys—			
(Pure-bred)	Bulls,	3	375 00
	Cows,	9	1,120 00
	Heifers,	7	525 00
Guernseys—			
(Pure-bred)	Bulls,	1	250 00
	Heifers,	3	225 00
(Grades)	Heifers,	1	45 00
Ayrshires—			
(Pure-bred)	Bulls,	1	100 00
	Cows,	2	165 00
	Heifers,	2	115 00

Short-horns			
(Grades)	Cows,	1	125 00
	Heifers,	1	75 00
	Total,	75	$7,925 00

SOLD.

(11)	Holstein (grade),	$607 00	
(2)	Guernseys (grade),	175 00	
(2)	Guernseys (pure-bred),	250 00	
(1)	Ayrshire (pure-bred),	65 00	
(2)	Bulls,	170 00	
			$1,267 00
Sale of calves,			170 60
			$1,437 60

PURCHASED.

(8)	Holstein grade cows,	$910 00	
(2)	Jersey heifers (pure-bred),	200 00	
(1)	Jersey bull (pure-bred),	25 00	
(1)	Holstein heifer (pure-bred),	100 00	
			$1,235 00

Other Additions to the Herd

The herd has been further improved by the addition of several very fine pure-bred animals which have been contributed by breeders in and out of the State. The department takes this opportunity of conveying its appreciation to the breeders who have shown such a kindly interest in the upbuilding of the herd. The animals donated are as follows:

A pure-bred Jersey bull, Lady's Napoleon Oxford, #127875, presented by the Charles Pratt Estate, Glen Cove, L. I. This bull is a grandson of Oxford Lad. He has extra good breeding on the dam's side, also.

Imp. Ravenscroft Golden Hope, #25175, presented by Mr. L. F. Loree, President of the Delaware and Hudson Railway, New York, N. Y. This is a pure-bred Guernsey bull, bred by John A. Kay, Ravenscroft, England, and imported by Mr. J. L. Hope, of Madison, N. J. He is a very superior individual.

Rutgers' White Champion, #19053, presented by Mr. Percival Roberts, Jr., Penshurst Farm, Narberth, Pa. Rutgers' White Champion is by Auchenbrain White Beauty's Champion, a son of Kate's Good Gift, who was out of Auchenbrain Brown Kate 4th. This cow held the world's record with a production of 23,022 pounds of milk in one lactation period. The sire of White Champion is out of Auchenbrain White Beauty 2d, who produced 14,721

pounds milk last year. On the dam's side, White Champion is equally as well bred. This bull has production, conformation, breeding and his dam and grand-dams have length of teats. He has, therefore, everything that is to be desired in a herd sire. Bred to suitable females, he should do much towards building up a first-class Ayrshire herd at this Station.

Rutgers Valdessa, #384338, presented by Mr. Bernhard Meyer, Finderne, N. J. This is a pure-bred Holstein heifer out of a 24-pound dam and of excellent breeding on the sire's side.

Mary Pietertje Alcartra, #348767, presented by Mr. A. A. Cortelyou, Bloomingdale Farm, Somerville, N. J. This Holstein heifer is by a son of the King of the Pontiacs and should give a good account of herself later on.

All of the above animals have been delivered to the herd and are in an excellent condition.

The herd is gradually shaping itself into something better. With the addition of the above-named animals and others that will be added from time to time, it should be only a matter of a few years when the department can afford to eliminate the grade animals, these to be replaced by pure-bred females.

Health of the Herd

The department has been particularly fortunate this year, having lost by death only one animal—a grade Holstein calf. The trouble due to contagious abortion so prevalent in the herd a few years ago seems to have been checked and the loss from this source reduced to a minimum. When purchasing new animals special precautions have been taken to keep these animals separate from the rest of the herd until the tuberculin test had been applied and the health of the animal vouched for by the Station's veterinarian. This rule applies even though the animals have been tuberculin tested at the time purchase had been made. Observations in this respect warrants the statement that where it becomes necessary to increase the herd by the addition of purchased animals, this is a very safe rule to follow if tuberculosis is to be kept out of the herd.

Production

The average production of the herd shows a marked increase over that of last year. Table I contains a full record of the herd for the year, together with the cost of production, profit per animal, and the returns for each dollar invested. It should be noted, however, that this does not include the cost of labor, interest on the investment, or cost of management.

Table I
Record of Production, Feed Cost and Profit

No. of Cow.	Age, Years.	Breed.	Months in Test.	Pounds Milk During Testing Period.	Average Test.	Pounds Butterfat During Testing Period.	Value of Milk.	Cost of Roughage.	Cost of Grain.	Total Cost of Feed.	Net Profit.	Returns for $1 Expended for Feed.	Feed Cost to Produce 100 Lbs. of Milk.
2, ...	9	G. H.	9	17,950.00	2.81	504.65	$501.37	$68.06	$83.82	$151.88	$349.49	$3.30	$0.84
4, ...	7	G. H.	8	4,969.80	3.55	175.21	139.09	68.19	37.01	105.20	33.89	1.32	2.11
7, ...	7	G. H.	7	4,893.40	3.71	181.80	136.54	67.81	40.03	107.84	28.70	1.26	2.23
11, ...	6	G. H.	10	6,509.40	3.21	218.97	180.41	68.19	42.32	110.51	69.90	1.63	1.69
12, ...	7	G. H.	10	6,437.60	3.22	207.44	179.58	68.19	45.11	113.30	66.28	1.58	1.75
14, ...	8	G. H.	11	9,639.50	4.01	387.33	270.61	66.10	65.36	131.46	139.15	2.05	1.37
17, ...	8	G. H.	9	9,106.60	3.27	297.86	252.84	66.41	76.93	143.34	109.50	1.76	1.57
18, ...	8	G. H.	9	7,634.20	3.12	238.33	213.03	65.78	54.82	120.60	92.43	1.76	1.57
64, ...	9	G. S.	11	9,797.90	4.06	398.26	273.66	65.61	68.04	133.65	140.01	2.04	1.36
19, ...	7	G. H.	10	11,177.30	3.42	380.26	309.72	64.47	63.30	127.77	181.95	2.42	1.14
102, ...		P. B. H.	10	12,902.10	3.73	485.07	362.50	65.81	72.11	137.92	224.58	2.62	1.06
301, ...	18	P. B. J.	12	6,024.00	4.56	274.87	168.11	54.97	55.49	110.46	57.65	1.52	1.83
302, ...	9	P. B. J.	10	6,627.50	5.24	347.48	187.72	52.43	54.30	106.73	80.99	1.75	1.61
303, ...	6	P. B. J.	10	5,121.70	4.44	227.66	142.90	54.36	48.91	103.27	39.63	1.38	2.01
304, ...	4	P. B. J.	11	6,040.00	5.92	357.70	168.49	54.23	49.51	103.74	64.75	1.62	1.71
305, ...	3	P. B. J.	11	4,929.71	4.60	226.81	137.54	51.68	45.34	97.02	40.52	1.41	1.96
401, ...	12	P. B. A.	8	5,724.70	3.49	199.80	159.72	59.02	49.71	108.73	50.99	1.47	1.89
101, ...	6	P. B. H.	10	10,548.30	3.06	322.90	294.32	64.33	69.43	133.76	160.56	2.20	1.26
307, ...	2	P. B. J.	8	3,008.00	3.40	102.49	83.92	37.49	33.51	71.00	12.92	1.18	2.36
32, ...	4	G. H.	8	6,640.30	3.67	243.79	184.08	41.30	51.27	92.57	91.51	1.98	1.39
35, ...	4	G. H.	8	5,124.56	4.81	246.96	193.44	42.58	52.35	94.93	98.51	2.03	1.85
36, ...	7	G. H.	6	5,524.10	3.43	189.62	154.14	31.29	39.71	71.00	83.14	2.17	1.28
37, ...	5	G. H.	6	6,290.20	3.29	207.22	175.53	31.26	46.17	77.43	98.10	2.26	1.23
38, ...	2	G. H.	6	4,754.00	3.32	157.87	132.66	30.43	40.80	71.23	61.43	1.86	1.49
39, ...	3	G. H.	5	4,695.60	3.06	143.94	131.02	27.76	31.60	59.36	71.66	2.42	1.26
19, ...	2	G. H.	5	3,610.10	3.45	124.60	100.74	27.76	32.87	60.63	40.11	1.67	1.67
306, ...	2	P. B. J.	9	5,799.30	4.92	285.62	161.80	43.20	40.35	83.55	78.25	1.93	1.44
23, ...	2	G. H.	3	1,286.30	4.04	52.02	35.89	15.09	16.51	31.60	4.29	1.13	2.45
21, ...	2	G. H.	3	2,162.00	3.71	83.59	60.32	16.48	17.85	34.33	25.99	1.75	1.58
103, ...	2	P. B. H.	3	1,664.30	3.67	61.23	46.44	16.83	16.51	33.34	13.10	1.39	2.00
404, ...	2	P. B. A.	2	1,313.80	3.98	52.55	36.66	9.07	13.90	22.97	13.69	1.59	1.74
30, ...	2	G. H.	2	831.30	3.50	29.10	23.19	8.69	12.23	20.92	2.27	1.10	2.51
104, ...	2	P. B. H.	2	1,794.40	3.49	62.83	50.08	11.41	15.92	27.33	22.75	1.82	1.53
44, ...	8	G. H.	1	809.10	3.19	25.80	22.58	5.81	1.65	7.46	15.12	3.02	.92
42, ...	4	G. H.	1	586.00	3.69	21.68	16.35	5.81	1.65	7.46	8.89	2.19	1.27
308, ...	2	P. B. J.	10da.	166.60	5.49	9.16	4.64	1.43	.41	1.84	2.80	2.52	1.10
Total, ...				202,191.67	3.72	7,532.56	$5,691.63	$1,529.33	$1.486.80	$3,016.13	$2,675.50	$1.88	$1.49
*Average, ...				9,505.90	3.72	354.14	$267.58	$71.90	$69.90	$141.80	$125.78	$1.88	$1.49

*Average per cow for 12 months.

For the year just closed, the average production of the herd was 9,505.9 pounds against 7,671.9 pounds for the previous year, an increase of 1,834 pounds per cow. This increase may be attributed to heavier feeding and also to the fact that most of the low producing animals have been removed from the herd. Attention might here be drawn to the production of cow No. 2. This cow produced less than 13,000 pounds last year and, while her last lactation period is not quite complete, it is now fairly safe to state that her production will exceed 21,000 pounds this year. Several of the pure-bred cows are being fitted and as they freshen will be entered in the advanced registry.

Feed Cost and Profit

Owing to a heavy advance in the cost of concentrates the feed cost per cow is about 40 per cent over that of last year. The average cost of feed per cow for the year is $141.80 as compared to $100.97 last year. As no pasture is available for the herd the feed cost of producing milk is considerably higher in the Station herd than would be the case otherwise. It will be seen from Table I that about 52 per cent of the feed cost was spent for roughage and that the other 48 per cent was expended for grain. The profit per cow is $125.78, and the feed cost per 100 pounds of milk produced was $1.49, which is equivalent to $0.032 per quart of milk produced.

Distribution of Production of Herd

Practically the whole production of the herd has been disposed of in the form of milk in bulk at prices ranging from 5 cents to 8 cents a quart. In the early part of the year the average price received for milk was slightly higher than 5 cents a quart; this price was increased gradually to an average of about 7 cents during the last month of the year. A small portion of the production was sold in the form of cream standardized to contain 35 per cent of butterfat. This was sold at $0.60 a quart.

MARKET PRICES PAID FOR FEED DURING THE YEAR

Hay and Ensilage

	Total Lbs. Fed.	Price per Ton.
Ensilage (corn),	506,000	$5.00
Ensilage (peas and oats),	43,970	5.00
Ensilage (soybeans),	7,700	5.00

Soiling Crops

Green Rye, ...	10,550	3.00
Green peas and oats, ...	5,920	5.00
Green soybeans, ...	2,660	5.00
Green grass, ...	1,080	5.00
Green clover, ...	1,435	5.00

Concentrates

	Total Lbs. Fed.	Price per Ton Nov. 1, 1916.	Price per Ton Nov. 1, 1915.	Average for Year.	Price per Ton 1914–15.
Hominy, ...	24,000	$38.00	$32.00	$34.35	.....
Corn Meal, ...	19,000	41.00	30.75	34.00	$30.00
Beet pulp, ...	20,000	32.00	27.00	29.00	26.00
Brewers' grains, ...	14,000	30.25	27.00	28.50	.....
Bran (wheat), ...	16,000	29.00	25.00	26.00	24.00
Gluten, ...	9,000	35.00	31.00	32.75	30.00
Ajax, ...	7,000	36.00	32.00	35.00	31.00
Cottonseed meal, ...	5,000	43.00	40.00	41.75	30.00
Oil meal, ...	4,500	40.00	35.25	38.25	38.00
Peanut meal, ...	2,000	40.00	40.00	40.00	32.00
Oats, ...	2,000	35.00	.....	35.00	.....
Cocoanut meal, ...	2,000	35.00	.....	35.00	26.00
Buckwheat middlings, ...	2,000	27.50	27.50	27.50	.....
	126,500			$31.00	
Salt, ...	3,100	23.00	15.00	18.00	.....

Market Prices Paid for Feed During the Year

Following is a statement which shows the average production of milk and butterfat, feed cost and profit, the milk being figured at 6 and 7 cents a quart and feed figured at prices charged by local 'dealers.

	Milk @ 6c. per Qt.	Milk @ 7c. per Qt.
Average lbs. milk per cow for 12 months, ...	9,505.9	9,505.9
Average value of milk, ...	$267.58	$312.79
Average cost of roughage, ...	71.90	71.90
Average cost of concentrates, ...	69.90	69.90
Average cost feed, ...	141.80	141.80
Average profit, ...	125.78	169.98
Average returns for $1.00 expended for feed, ...	1.88	2.20
Average cost to produce 100 lbs. milk, ...	1.49	1.49
Average cost to produce 1 qt. of milk, ...	.032	.032

Total Cost of Milk Based on Market Prices of all Feeds

Cost of feed per cow for the year, ...	$141.80	
Cost of labor, ...	28.00	
Cost of bedding (shavings @ $5 per ton), ...	4.50	
Cost of depreciation on utensils, ...	1.50	
Interest on investment (6% on $10,000), ...	16.21	
Sundries, ...	3.00	
		$195.01
Value of milk per cow @ 5c. per qt., ...	$221.04	
Value of manure per cow, ...	12.00	
Total, ...		$233.04
Total cost per cow per year, ...		195.01
Profit per cow per year, ...		$38.03
Value of milk per cow @ 6c. per qt., ...	$267.58	
Value of manure per cow, ...	12.00	
Total, ...		$279.58
Total cost per cow per year.		195.01
Profit per cow per year, ...		$84.57

Cost per cow per day for roughage,	$ .197
Cost per cow per day for grain,	.190
Cost per cow per day for labor,	.075
Cost per cow per day for bedding,	.012
Cost per cow for depreciation and interest,	.048
Total cost per cow per day,	.522
Value of milk per cow per day,	.733
Profit per cow per day,	.211
Total cost per quart of milk,	.044

Feed Cost of Raising Calves

In keeping with the policy of the department in former years a complete record of the feed cost of raising heifers and calves has been maintained. Full information concerning feed cost for the different breeds may be found in Table II of this report. Considerable data may be gathered from this report as a careful record has been kept of all feed fed. The roughage and concentrates have been charged at regular market prices, the whole milk at 5 cents a quart, and skim milk at one-half cent per quart. It will be seen that the cost of raising 34 heifers to an average age of 8.55 months is $40.71 for each heifer. Compared with the cost of raising heifers for the previous year, it will be noted that there has been an increase in cost of nearly 50 per cent. This increase must be attributed to the heavy increase in cost of feed, as practically the same method of feeding has been followed throughout the 2 years.

A careful perusal of the report will show that the average cost of raising calves for the first two months is about $7.50 per month. This cost diminishes gradually, and at the age of 12 months the average cost is about $4.50 per month. The higher cost in the earlier period of the heifer's life is no doubt due to the relatively high cost of the milk fed.

The method of raising heifers followed at this Station is given in Table III. This method has been found to give very good results. The absence of scours or any other form of sickness in the young stock has been particularly noticeable this year. Special precautions have been taken to see that the calf pens are thoroughly cleaned each day and disinfected at regular intervals, that the pails are sterilized and that no tainted or objectionable feed is fed.

Following is the mixture of grain which has been fed to heifers during the past year: Corn meal, 2 parts; bran (wheat), 1 part; oats (ground), 1 part; oil meal, 1 part.

This ration has given very good results. The young calf is usually left on the mother for the first 48 hours. It is then removed and fed from a pail, the quantity of whole milk varying from 6 to 8 quarts according to the size and physical con-

Table II

Summary of Feed Fed and Costs of Feed for Calves

No. of Calf.	Months in Herd.	Whole Milk, Lbs.	Skim Milk, Lbs.	Pasture Days.	Hay, Lbs.	Silage, Lbs.	Green Feed, Lbs.	Grain, Lbs.	Cost of Milk.	Cost of Roughage.	Cost of Grain.	Total Cost.
						Holstein						
20	12	....	....	184	1,398	4,800	....	1,047.11	....	$33.71	$16.61	$50.32
19	5	....	....	....	1,268	3,920	....	378.3	....	22.47	5.70	28.17
27	12	....	....	184	1,558	4,940	....	1,001.61	....	35.46	16.19	51.65
28	12	....	....	123	1,403	4,640	....	1,017.81	....	33.91	16.20	50.11
31	12	....	....	153	1,388	4,690	....	970.8	....	33.11	17.07	50.18
23	9	....	....	92	1,618	3,996	....	755.8	....	29.93	11.75	41.68
30	10	....	....	123	1,598	3,945	....	848.5	....	30.85	13.30	44.24
21	9	....	....	....	1,838	7,050	1,240	804.3	....	38.80	12.57	51.37
40	10	906	....	....	881.8	1,934.5	427	1,033.26	$20.84	14.65	16.88	52.37
24	10	....	....	123	1,456	4,710	....	1,129.8	....	31.34	16.18	47.52
104	9	....	....	....	1,718	7,630	1,220	781.3	....	38.99	12.12	51.11
103	9	....	....	92	1,578	3,945	....	739.9	....	29.40	11.50	40.90
105	12	....	....	152	1,823	5,145	....	995.91	....	37.35	15.96	53.31
106	10	....	360	92	1,090	3,140	....	926.24	.83	22.52	15.07	38.42
107	2	496	....	....	61	122	....	152.67	11.40	.92	2.87	15.19
Totals,	....	1,402	360	1,318	20,676.8	64,606.5	2,887	12,583.31	$33.07	$433.41	$200.06	$666.54
Average per calf	9.53+	93.4	24	87.86	1,378.45	4,313.1	125.8	838.88	$2.20	$28.90	$13.33	$44.43
						Jersey						
308	11	....	....	91	1,886	4,900	....	903.66	....	$34.86	$15.26	$50.12
309	12	....	....	92	2,196	5,610	....	1,028.68	....	38.54	17.02	55.56
306	2	....	....	....	565	1,000	....	90.0	....	8.16	1.33	9.49
307	3	....	....	....	748	1,875	....	154.0	....	12.17	2.23	14.40
310	10	894	....	....	918.5	2,163	420	1,104.04	$20.57	15.55	18.19	54.31
311	10	894	....	....	918.5	2,153	420	1,124.04	20.57	15.55	18.19	54.31
312	10	708	1,104	....	673.5	1,371	305	873.01	18.83	11.63	13.90	44.36

Table II (Continued)

Summary of Feed Fed and Costs of Feed for Calves

No. of Calf.	Months in Herd.	Whole Milk, Lbs.	Skim Milk, Lbs.	Pasture Days.	Hay, Lbs.	Silage, Lbs.	Green Feed, Lbs.	Grain, Lbs.	Cost of Milk.	Cost of Roughage.	Cost of Grain.	Total Cost.
						Jersey—Continued.						
313	10	1,002	1,104	....	612.5	1,187	305	736.21	$27.06	$11.21	$11.86	$50.73
314	9	720	1,104	....	767.5	1,187	150	736.21	19.10	11.67	11.86	42.63
315	2	310	300	....	242	365	....	212.58	7.82	3.33	3.36	14.51
316	2	310	300	....	242	365	....	212.58	7.82	3.33	3.36	14.51
Totals,	....	4,928	3,912	183	9,769.5	22,176	1,600	7,234.99	$122.37	$106.00	$116.56	$404.93
Average per calf,	7.30+	148	355.6	16.6	888.1	2,016	145.4	657.72	$11.12	$15.00	$10.60	$36.81
						Guernsey						
203	7	372	1,402	....	399	857	152	563.13	$33.11	$6.09	$8.98	$49.08
204	3	....	....	....	552	858	....	398.06	....	7.67	6.75	14.42
205	3	....	....	....	430	706	....	336.58	....	6.07	5.80	11.96
66	10	906	....	....	888.5	1,920	427	1,078.86	20.84	14.68	16.58	52.10
Totals,	....	1,278	1,402	....	2,209.5	4,341	579	2,376.63	$53.95	$35.41	$38.20	$127.56
Average per calf,	5.75	319.5	350	....	567.3	1,085	144.7	594.15	$13.49	$8.85	$9.55	$31.89
						Ayrshire						
405	12	....	....	154	1,211	4,540	....	895.6	....	$29.71	$14.24	$43.95
404	10	....	....	92	1,509	4,010	....	831.06	....	28.87	13.20	42.07
403	12	....	....	123	1,936	5,780	....	979.5	....	38.93	17.33	56.26
Totals,	....	....	....	369	4,656	14,330	....	2,706.16	....	$97.51	$44.77	$142.28
Average per calf,	11.3 +	....	....	123	155.2	4,776	....	902.05	....	$32.51	$14.02	$47.43

Table II (Continued)

Summary of Feed Fed and Costs of Feed for Calves

No. of Calf.	Months in Herd.	Whole Milk, Lbs.	Skim Milk, Lbs.	Pasture Days.	Hay, Lbs.	Silage, Lbs.	Green Feed, Lbs.	Grain, Lbs.	Cost of Milk.	Cost of Roughage.	Cost of Grain.	Total Cost.
						Short-horn						
65	10	....	....	184	968	3,775	....	998.66	....	$26.65	$16.13	$42.78
Totals, ...	....	....	....	184	968	3,775	....	998.66	....	26.65	16.13	42.78
Average per calf, ...	10	....	....	184	968	3,775	....	998.66	....	26.65	16.13	42.78
Totals for all calves, ...	....	7,008	5,674	2,054	38,339.8	109,318.5	5,060	25,899.75	$209.39	$758.98	$415.72	$1,384.09
Average for all calves, ...	8.55	223.7	137.4	60.4	1,127.6	3,215.2	119.5	761.4	$6.16	$22.32	$12.23	$40.71

dition of the calf. For the first four or five days the calf is fed frequently at the rate of 1 to 2 quarts per feed. At the end of 2 weeks the whole milk is substituted for skim milk, this change being made at the rate of 1 pound a day. The calf is then offered alfalfa leaves and meal in very small quantities, care being taken to see that all stale feed is removed from the feed boxes regularly.

Table III

Method of Feeding Heifers from Birth until Three Months Old

Feed Consumed in Pounds

Age in Days	Whole Milk	Skim Milk	Grain	Clover or Alfalfa Hay	Silage
1	With Mother	..	....	...	...
2	" "	..	....	...	...
3	8	..	....	...	...
4	10	..	....	...	...
5	11	..	....	...	...
6	12	..	....	...	...
7	12	..	....	...	...
8	12	..	....	...	...
9	12	..	....	...	...
10	12	..	....	...	...
11	12	..	....	...	...
12	13	..	2 oz.	¼	...
13	14	..	2 "	¼	...
14	14	..	2 "	¼	...
15	15	..	2 "	¼	...
16	16	..	2 "	¼	...
17	15	1	2 "	¼	...
18	14	2	2 "	¼	...
19	13	3	3 "	¼	...
20	12	4	3 "	¼	...
21	11	5	3 "	¼	...
22	10	6	4 "	¼	...
23	9	7	4 "	¼	...
24	8	8	4 "	¼	...
25	7	9	4 "	½	...
26	6	10	5 "	½	...
27	5	11	5 "	½	...
28	4	12	5 "	½	...
29	3	13	5 "	½	...
30	..	16	6 "	½	½
35	..	16	7 "	1	½
40	..	16	9 "	1	½
45	..	16	10 "	1	½
50	..	12	12 "	1	1
60	..	6	14 "	1½	1
70	..	..	2 lbs.	2	2
80	..	..	2½ "	2½	2
90	..	..	3 "	3	3

Feeding Cost for Bulls

Table IV contains a summary of the feed fed and cost for bulls maintained in the College herd during the year.

Table IV

Summary of Feed Fed and Costs of Feed for Bulls Maintained in the Herd

NAME.	Months in Herd.	Breed.	Whole Milk, Lbs.	Skim Milk, Lbs.	Pasture.	Hay, Lbs.	Silage, Lbs.	Green Feed, Lbs.	Grain, Lbs.	Cost of Milk.	Cost of Roughage.	Cost of Grain.	Total Cost.
Imp. Ravenscroft Golden Hope, No. 25175, ..	5	P. R. G.	....	....	....	886	2,915	837	976.7	....	$17.82	$16.14	$33.96
Rutger's White Champion, No. 10053, ...	1½	P. R. A.	796	....	....	61	122	....	61.92	$18.31	.92	2.18	21.41
Finderne Schwartz Vorndyke, No. 131811, ...	12	P. B. H.	....	....	....	1,987	6,887	837	1,600.4	....	37.79	29.93	67.72
Lady's Napoleon Oxford, No. 127875, ...	9	P. B. J.	....	....	....	1,551	4,055	744	1,371.9	....	27.15	22.38	49.53
Rutger's *Combination*, No. 143850, ...	1¼	P. R. J.	....	....	....	795	1,043	....	393.6	....	10.00	7.40	17.49
Totals, ...	....	....	796	....	....	5,280	15.022	2,418	26.045.02	$18.31	$93.77	$78.03	$190.11
Av. per bull, ...	5¾	....	159.2	....	....	1,056	3,004	483.6	529.0	*$3.66*	*$18.75*	*$15.61*	*$38.02*

IV

COW TESTING ASSOCIATIONS

There are 5 cow testing associations in the State, 2 of which were organized during the past year. The interest in this line of work seems to be increasing rapidly, and there is a possibility of several new associations being organized before the close of another year. In the early part of the year Mr. John W. Bartlett was appointed Extension Specialist in Dairy Husbandry under the direction of the Extension Division but working in coöperation with the Dairy Department. Supervision of the cow testing associations has been placed under his charge, and this plan has been found to work very well since he is in a position to give the necessary time and attention which this important line of work demands. In order to encourage the work, the Dairy Department furnishes all necessary blanks for keeping the records, free of charge, and in coöperation with the Extension Division compiles the yearly records.

There has been a heavy increase in the price of feed and labor during the past year, which has not been accompanied by a corresponding increase in the selling price of milk, and it is doubtful if any more convincing demonstration could be placed before the dairymen of the State which would be the means of educating them to the necessity of eliminating from their herds the low-producing, unprofitable cows than through a well organized and well managed cow testing association.

In order to facilitate the securing of supervisors promptly, and to minimize the expense to the breeder, the supervisors in charge of the cow testing associations have been permitted to do semi-official tests for breeders who happen to be members of cow testing associations. The department is careful, however, to see that the supervisor is fully qualified to perform the work. All tests are vouched for by head of the department and accepted by the different breed associations.

A list of the associations in the State at the present time, together with the names of the officers, is as follows:

Sussex County Cow Testing Association:
President—W. S. Hibler, Newton, N. J.
Vice-President—
Secretary-Treasurer—W. F. Whittemore, Newton, N. J.
Official Tester—Harry Watt, Newton, N. J.
Number of members, 18; number of cows, 518.

Wallkill Valley Cow Testing Association:
President—J. S. Katzenstein, Hamburg, N. Y.
Vice-President—Alfred Ely, 31 Nassau St., New York City.
Secretary-Treasurer—T. M. Roe, Branchville, N. J.
Official Tester—T. C. McIlvaine, Sussex, N. J.
Number of members, 12; number of cows, 423.

Salem County Cow Testing Association:
President—Edgar Moore, Woodstown, N. J.
Vice-President—
Secretary-Treasurer—Asher B. Waddington, Woodstown, N. J.
Official Tester—J. H. Dumm, Sussex. N. J.
Number of members, 22; number of cows, 582.

Burlington County Cow Testing Association:
President—J. V. Bishop, Columbus, N. J.
Vice-President—
Secretary-Treasurer—Walter Reeder, C. C. Tallman.
Official Tester—M. A. Thomson.
Number of members, 9; number of cows, 410.

Bergen and Passaic County Cow Testing Association:
President—D. Y. Lewis, R. D., Westwood, N. J.
Vice-President—F. T. Torbet, R. D. No. 1, Paterson, N. J.
Secretary-Treasurer—H. D. Bennet, Ridgewood, N. J.
Official Tester—Albert Smith, Jr., Ridgefield Park, N. J.
Number of members, 23; number of cows, 577.

A full record of the production, feed consumed, feed cost, profit per cow, and the average of two associations, namely, Salem County Cow Testing Association and Wallkill Valley Cow Testing Association, is contained in Tables V to VIII of this report. In compiling these records the feed is charged at the market value of the feed on the farm, and pasture is charged at the rate of $1.25 per cow per month. A perusal of these records will show that the average cost of producing a quart of milk in the Salem County Cow Testing Association was $.0195, and in the Wallkill Valley Cow Testing Association the cost per quart was $.0204. As previously stated, the cost to produce a quart of milk in the Station herd for the past year was $.032. This wide difference in cost of production may be attributed to the fact that no pasture is available for the Station herd. It may be noted, however, that notwithstanding the higher cost of production, the average profit per cow in the Station herd was $125.78 against $83.64 and $47.18 in the two associations mentioned.

A summary shows that the average number of cows in the two associations for 12 months was 819. This average is determined by adding the total number of months each cow was on record and dividing the result by 12. The average production of the 819 cows was 7,424.89 pounds of milk and 288.74 pounds

of butterfat, with an average test of 3.75 per cent butterfat. Considering the number of cows on test, and that both of these are comparatively new associations, the record is a fairly creditable one. Fully 90 per cent. of all the cows on test were high-grade Holsteins which were practically all sired by pure-bred bulls.

Variation in Yield of Milk and Butterfat in Two Cow Testing Associations

2 herds over 10,000 lbs. milk.	2 herds over 400 lbs. butterfat.
3 herds 9,000 to 10,000 lbs. milk.	10 herds 350 to 400 lbs. butterfat.
6 herds 8,000 to 9,000 " "	9 herds 300 to 350 " "
5 herds 7,000 to 8,000 " "	6 herds 250 to 300 " "
9 herds 6,000 to 7,000 " "	5 herds 200 to 250 " "
8 herds 5,000 to 6,000 " "	2 herds 150 to 200 " "
1 herd 4,000 to 5,000 " "	
Highest yield (Herd M), 11,019.56.	Highest yield (Herd M), 440 lbs.
Lowest yield (Herd N). 4,360.00.	Lowest yield (Herd K), 153.4 "
Average 34 herds, ... 7,424.89.	Average 34 herds, ... 339.7 "

V

ADVANCED REGISTRY WORK

Supervision of Official Tests for Breeders of Pure-Bred Dairy Stock

The demand upon the department for competent men to conduct official and semi-official tests of pure-bred dairy cows for entry in the advanced registry of the different breed associations is increasing from year to year. From the fact that little or no official testing is done during the summer months, and also that there are so many attractive positions open in dairying, the problem of securing competent men for a period of 6 months of each year to perform this work is becoming more and more difficult. Many of our breeders fail to give the department sufficient notice when a supervisor is required, and, in order to oblige them, often our routes are badly disorganized. If all the breeders would give the department notice at least one week before a supervisor will be required, considerable expense and inconvenience could be saved to the department and to the breeder as well. The following is a summary of all official tests supervised by the Department during the past year.

Official Tests:

Seven-day tests,	215
Fourteen-day tests,	...
Thirty-day tests,	29
Total number of breeders doing official testing,	31

List of Breeders for Whom Official Tests were Conducted:

American Live Stock Association,	New York, N. Y.
Apgar, Mr. S.,	Milford, N. J.
Allamuchy Farms,	Allamuchy, N. J.
Avery, I. M.,	Sparta, N. J.
Bartles, John P.,	Flemington, N. J.
Baylor, Mr. Theo. T.,	Hampton, N. J.
Bergen, Mr. J. V. D.,	Belle Meade, N. J.
Boston, Mr. L. N.,	Clarksboro, N J.
Brill, E. C.,	Stewartsville, N. J.
Cortelyou, A. A.,	Somerville, N. J.
Crispin, F. W., Sr.,	Woodstown, N. J.
Drake, J. G.,	Somerville, N. J.
Drew, Leon,	Newton, N. J.
Freedman, Andrew,	Red Bank, N. J.
Von Garrel, Frank	Montvale, N. J.
Jarvie, James N.,	Beemerville, N. J.
Massenat, Mrs. Helen L.,	Belvidere, N. J.
Meyer, Bernhard,	Finderne, N. J.
Nevius, J. N.,	North Branch, N. J.
Quick, Fred A.,	*Neshanic Station, N. J.*
Quick, J. D.,	South Branch, N. J.
Reynolds, W. A.,	Lyons, N. J.
Ryman, K. L.,	White House, N. J.
Roberts, C. L.,	Basking Ridge, N. J.
Roe, Mr. I. N.,	Branchville, N. J.
Scudder, Mrs. H. C.,	Trenton, N. J.
Sharpe, John C.,	Blairstown, N. J.
Stryker, W. E.,	Belle Mead, N. J.
Tranquillity Farms,	Allamuchy, N. J.
Van Doren, John H.,	Three Bridges, N. J.
Wilson, G. D.,	Somerville, N. J.

Semi-Official Tests:	*Breed.*	*No. of Tests.*	*No. of Cows.*
Crispin, C. L., Woodstown, N. J.,	Holstein	4	1
Jarvie, J. N., Beemerville, N. J.,	"	1	1
Roe, I. N., Branchville, N. J.,	"	58	16
Scudder, Mrs. H. C., Trenton, N. J.,	"	14	4
Total,		77	22

Guernsey Two-day Tests:		*No. of Tests.*	*No. of Cows.*
Israel, Leon,	Far Hills, N. J.,	20	2
Cleveland, C. D.,	Eatontown, N. J.,	20	3
De Mott, Wm.,	Millington, N. J.,	6	2
Haskell, J. A.,	Red Bank, N. J.,	58	13
Hope, J. L.,	Madison, N. J.,	219	42
James, D. Willis,	Madison, N. J.,	8	3
Leeds, H. W.,	Westville, N. J.,	72	13
Pyne, P. R.,	Bernardsville, N. J.,	74	11
Roebling, F. W.,	Trenton Junction, N. J.,	47	10
Strawbridge, E. W.,	Moorestown, N. J.,	43	13
Wendover Farms,	Bernardsville, N. J.,	23	5
Zehnder, C. H.,	Allenhurst, N. J.,	14	4
Total,		604	122

Jersey Two-day Tests:			
Batten, George,	Caldwell, N. J.,	51	14
Martin, R. L.,	Princeton, N. J.,	97	11
Hamilton Farms,	Gladstone, N. J.,	34	8
Turner, James,	Sussex, N. J.,	21	3
Young, Henry,	Bernardsville, N. J.,	2	1
Total,		205	37

Ayrshire Two-day Tests:			
Wendover Farms,	Bernardsville, N. J.,	28	5
Stetson, F. L.,	Sterlington, N. Y.,	82	21
Schley, Grant B.,	Far Hills, N. J.,	29	7
Total,		139	33

Brown Swiss Two-day Tests:		
Kinney, Warren, ...Butler, N. J.,	60	8
Total,	60	8
Total number of two-day tests, including Holstein semi-official tests,		1,085
Total number of cows under monthly test,		222
Total number of breeders conducting two-day test,		25

A summary of Tables IX to XV, inclusive, is contained in Tables XV and XVI. In order to arrive at a fair comparison between the breeds the profits have been figured on the basis of 5 cents per quart of milk and also at 50 cents per pound of butterfat. A perusal of Table XVIII will show that when the butterfat production is taken into account the difference in profit between the breeds is not so great as when figured on the basis of milk production alone.

VI

TESTERS' LICENSE DIVISION

During the last session of the State Legislature a law regulating the weighing, testing and purchasing of milk and cream in certain cases was passed. This law was approved on March 8, 1916, and went into effect September 1, 1916. The law, with other things, requires that all glassware used in connection with the Babcock test, or any other instrument used for the purpose of determining the percentage of butterfat contained in milk and cream, must be inspected and approved by the director of the New Jersey Agricultural Experiment Station, also that every buyer of milk and cream shall have in his employ a licensed tester who shall procure this license from the New Jersey Agricultural Experiment Station.

Full information concerning the requirements of this law may be found in Circular 62 of the Experiment Station, prepared by this department. This circular will be mailed to any person on request.

Testers' Licenses

During the first two months after this law went into effect there were 41 candidates who took the examination. Of these, 34 were successful. Applicants who failed on the first examination have the privilege of taking a second examination.

Table IX

Seven-day Holstein Record Showing Estimated Production and Feed Consumed

Herd Letter.	No. of Cows.	Yield During Period.			Pounds of Feed Consumed.														
		Milk, Lbs.	% Fat.	Lbs. Fat.	Soiling Crops.	Hay.	Corn Fodder.	Silage.	Roots.	Corn Stover.	Corn Stalks.	Cocoanut Meal.	Larro Feed.	Oats.	Brewers' Grains.	Bran.	Oil Meal.	Gluten.
A,	3	919.1	3.66	38.23	....	210.	105.	....	....	......	......	......	43.2	....	....	....	....	....
B,	1	411.6	3.91	16.11	....	56.	......	140.	280.0	......	......	......	......	19.70	19.70	19.70	19.70	29.60
C,	2	853.1	3.65	31.19	....	168.	......	....	1,120.0	......	......	......	43.0	43.00	....	43.00	43.00	43.00
D,	3	1,423.9	3.82	54.46	....	182.	......	420.	1,015.0	......	......	......	......	89.80	....	103.30	22.96	54.80
E,	2	853.1	3.65	31.19	....	168.	......	....	1,120.0	......	......	......	43.0	43.00	....	43.00	43.00	43.00
F,	2	878.3	3.86	33.95	560.	....	......	260.	....	......	......	......	......	38.50	....	30.80	30.80	38.50
G,	3	1,377.2	3.14	43.32	....	840.	......	630.	....	......	......	......	......	89.75	89.75	89.75	29.25	29.25
H,	4	1,565.6	3.84	60.12	....	175.	......	458.	....	......	......	......	......	64.40	71.20	72.60	74.70	....
I,	16	6,163.6	4.18	258.42	....	1,127.	......	1,120.	2,388.1	......	......	......	......	135.80	281.38	308.08	256.18	437.36
J,	5	2,072.8	4.27	88.66	....	350.	......	1,050.	....	......	......	......	......	67.20	84.00	132.00	132.00	65.80
K,	6	2,350.0	3.07	82.34	....	965.	......	....	....	......	......	......	......	147.00	....	137.00	95.75	19.50
L,	5	2,227.1	3.22	71.83	....	350.	......	700.	1,540.0	......	......	......	......	147.50	....	147.50	86.50	....
M,	5	1,949.2	3.27	63.89	....	1,400.	......	....	1,060.0	......	......	......	......	73.75	133.75	139.75	64.50	56.50
N,	4	1,568.3	2.97	46.59	....	326.	......	560.	....	......	......	......	......	....	....	....	202.00	202.00
O,	1	369.9	4.01	14.83	....	56.	......	70.	....	......	......	......	......	....	....	20.00	66.50	66.50
P,	1	397.0	2.98	11.63	....	95.	......	....	300.0	70.	......	......	......	25.80	25.80	....	20.60	....
Q,	3	1,005.1	3.29	33.13	....	168.	......	....	....	......	210.	......	......	....	117.60	....	....	137.70
R,	2	759.0	3.74	28.41	....	140.	......	....	964.0	210.	......	......	......	46.70	52.20	52.20	....	46.70
S,	2	972.5	3.49	33.99	....	140.	......	....	....	......	......	......	......	59.00	....	59.00	59.00	....
T,	5	1,949.2	3.27	63.89	....	1,400.	......	....	1,050.0	......	......	......	......	74.50	132.75	132.75	64.50	58.75
U,	5	1,811.5	3.81	69.07	....	434.	......	805.	840.0	......	......	......	......	57.40	112.00	134.40	134.40	95.90
V,	31	12,556.6	4.37	549.50	....	2,032.	......	2,765.	1,414.0	......	......	24.	......	174.05	193.85	386.85	149.85	....
W,	36	16,570.7	3.77	625.61	....	2,044.	......	3,524.	6,310.0	......	......	......	......	802.95	....	858.71	401.34	416.69
X,	15	5,967.8	3.84	229.40	....	8,400.	......	1,890.	1,400.0	......	......	......	......	38.75	....	277.06	99.22	87.25
Y,	24	9,097.1	3.52	320.65	630.	2,310.	......	870.	3,136.0	......	504.	......	......	75.00	498.00	584.60	445.40	....

Table IX—Continued

Seven-day Holstein Record Showing Estimated Production and Feed Consumed

Herd Letter.	No. of Cows.	Yield During Period. Milk, Lbs.	% Fat.	Lbs. Fat.	Pounds of Feed Consumed. Soiling Crops.	Hay.	Corn Fodder.	Silage.	Roots.	Corn Stover.	Corn Stalks.	Cocoanut Meal.	Larro Feed.	Oats.	Brewers' Grains.	Bran.	Oil Meal.	Gluten.
Z, ...	11	4,885.4	3.73	182.52	280.	679.	......	1,421.	3,220.0	......	......	......	......	132.28	......	208.96	79.03	116.88
A 1, ...	4	1,410.3	3.25	45.82	......	336.	......	......	......	......	......	......	......	......	112.00	35.00	28.00	28.00
A 2, ...	2	715.2	3.31	23.72	......	310.	......	......	280.0	......	......	......	......	54.30		54.30	54.30	......
A 3, ...	1	354.3	3.58	12.69	......	84.	......	252.	......	......	......	......	......	16.30	......	21.30	4.00	14.20
A 4, ...	7	2,910.7	3.45	100.51	......	315.	......	1,029.	875.0	......	......	......	......	......	14.98	122.75	127.31	125.45
A 5, ...	1	658.9	2.84	18.70	......	70.	......	......	385.0	......	......	......	......	28.00	......	28.00	35.00	......
Total, ...	212	87,002.1	3.77	3,282.37	1,470.	25,330.	105.	17,970.	28,387.1	280.	714.0	21.	129.2	2,342.43	1,938.96	4,235.26	2,867.79	2,208.33
*Average, ..	......	410.39	3.77	15.47	6.93	119.52	0.49	84.76	133.9	1.31	3.32	0.11	0.60	11.04	9.13	19.97	13.52	10.41

* Average per cow.

Table IX—Continued

Seven-day Holstein Record Showing Estimated Production and Feed Consumed

Herd Letter.	No. of Cows.	Hominy.	Cottonseed Meal.	Corn-meal.	Molasses.	Ajax.	Beet Pulp.	Schumaker.	Sucrene.	Salt.	Distillers' Grains.	Union Grains.	Alfalfa Meal.	Purina.	Buckwheat Meal.	Corn and Cob Meal.	Charcoal.	Peanut Meal.	Ground Corn.
		POUNDS OF FEED CONSUMED.																	
[illegible]	3																		
[illegible]	1	29.60	29.60																
[illegible]	2	43.00																	
[illegible]	3		100.10	38.90	4.50														
[illegible]	2	43.00																	
[illegible]	2		30.80			61.60	77.00												
[illegible]	3		29.25	29.25			210.00												
[illegible]	4		74.70			81.20		83.30											
[illegible]	16	155.68	210.68	225.68			688.00	144.50		68.60									
[illegible]	5	132.00	132.00																
[illegible]	6		95.75	174.00			317.5				76.25	65.9							
[illegible]	5		17.00	86.50							155.50								
[illegible]	5		36.00					17.00											
[illegible]	4							167.00					167.0						
[illegible]	1	10.01	6.65		10.50	20.02	35.00												
[illegible]	1		37.60												25.8				
[illegible]	3		69.00						137.7							137.7			
[illegible]	2		38.40																
[illegible]	2		29.00	59.00															
[illegible]	5		28.25					17.00											
[illegible]	5	73.00	60.90	35.00		57.40											8.40		
[illegible]	31	469.70	386.80				1,064.00	199.00					193.0					58.	
[illegible]	36	76.87	453.41		10.5m	810.17	1,869.00				21.00						115.75		
[illegible]	15	121.10	87.43		7.98	277.06	707.00				52.50								86.
[illegible]	24	888.20	224.90				223.5				233.90								

Table IX—Continued

Seven-day Holstein Record Showing Estimated Production and Feed Consumed

HERD LETTER.	No. of Cows.	POUNDS OF FEED CONSUMED.																	
		Hominy.	Cottonseed Meal.	Corn-meal.	Molasses.	Ajax.	Beet Pulp.	Schumaker.	Sucrene.	Salt.	Distillers' Grains.	Union Grains.	Alfalfa Meal.	Purina.	Buckwheat Meal.	Corn and Cob Meal.	Charcoal.	Peanut Meal.	Ground Corn.
E, ...	11	......	112.30	......	7.00	212.98	126.00	......	......	4.48	......	......	......		......	......	18.03	......	......
A 1, ...	4	56.00	28.00	......	......	28.00	......	35.00	......	......	......	......	......	35.	......	......	......	......	......
A 2, ...	2	......	27.10	54.30	......	......	245.00	......	......	2.70	......	......	......	......	......	......	2.70	......	......
A 3, ...	1	12.10	......	......	......	......	......	......	......	......	36.60	......	......	......	......	......	3.00	25.	......
A 4, ...	7	110.85	158.53	......	13.50	......	310.00	49.15	......	1.25	78.85	......	......	......	......	5.0	13.15	......	......
A 5, ...	1	33.00	28.00	......	......	......	......	21.00	......	......	28.00	......	......	......	......	......	......	......	......
Total, ...	212	2,256.11	2,527.15	702.63	53.98	1,548.43	5,872.00	732.95	137.7	7.03	682.60	65.9	360.0	35.0	25.8	142.7	161.03	83.0	86.
*Average, ..	......	10.63	11.92	3.81	0.25	7.30	27.69	3.45	0.65	0.03	3.21	0.31	1.69	0.16	0.12	0.67	0.75	0.39	0.40

* Average per cow.

Table X

Thirty-day Holstein Record Showing Estimated Production and Feed Consumed

HERD LETTER.	No. of Cows.	YIELD DURING PERIOD.			POUNDS OF FEED CONSUMED.																
		Milk, Lbs.	% Fat.	Lbs. Fat.	Hay.	Silage.	Roots.	Bran.	Gluten.	Cottonseed Meal.	Hominy.	Oil Meal.	Brewers' Grains.	Schumaker.	Corn-meal.	Ground Oats.	Distillers' Grains.	Beet Pulp.	Ajax.	Charcoal.	Salt.
....	1	1,672.0	3.95	66.15	180.	900.	....	90.0	90.0	90.0	90.0	120.0	120.0	......	......	......	......	....	......	......	......
....	8	15,837.1	3.63	576.88	2,240.	3,240.	2,200.	573.8	987.8	589.6	611.8	545.9	526.9	316.	376.	......	60.	Dry 2,500.0	......	......	......
....	1	2,508.4	3.91	99.00	240.	750.	600.	82.8	164.4	82.2	164.4	82.2	123.3	......	......	82.2	......	300.	......	......	......
....	3	6,891.4	3.64	251.32	1,080.	2,160.	3,600.	245.7	....	161.0	....	102.2	....	......	......	154.8	......	100.0	245.7	11.7	85.0
....	1	2,280.2	3.28	75.11	300.	750.	....	....	....	....	193.0	96.0	116.0	......	......	......	......	118.0	......	......	......
....	4	8,400.0	3.76	315.85	960.	3,600.	1,680.	480.0	120.0	157.5	240.0	157.5	....	......	......	......	......	960.0	......	......	......
....	1	1,958.3	4.64	90.83	240.	450.	....	300.0	38.5	30.8	....	28.8	....	......	......	48.1	......	76.9	76.9	......	......
....	4	8,995.5	4.75	427.72	1,060.	1,800.	1,350.	221.7	221.7	....	558.2	221.7	221.7	......	......	49.5	......	Dry 630.0	......	......	......
....	6	11,202.5	3.46	388.51	2,100.	2,250.	7,500.	526.4	526.4	526.4	246.0	526.4	....	......	......	436.4	......	....	436.4	180.0	......
Total, ...	29	59,752.8	3.83	2,291.37	8,430.	15,900.	16,930.	2,520.4	2,148.8	1,657.5	2,098.4	1,880.6	1,107.9	316.	376.	771.0	60.	4,684.9	759.0	191.7	85.0
*Average,	....	2,060.42	3.83	78.81	290.34	54.82	583.79	86.91	74.09	57.15	72.35	64.84	38.20	10.89	12.96	26.58	2.06	161.54	26.17	6.61	2.93

* Average per cow.

Table XI

Semi-Official Holstein Records Showing Estimated Production and Feed Consumed

No. of Cow.	Months.	YIELD DURING PERIOD. Milk, Lbs.	% Fat.	Lbs. Fat.	POUNDS OF FEED CONSUMED. Pasture Days.	Hay.	Roots.	Silage.	Soiling Crops.	Corn Fodder.	Corn Stover.	Bran.	Cottonseed Meal.	Ajax.	Oats.	Oil Meal.	Molasses.	Distillers' Grains.	Beet Pulp.	Unicorn.	Schumaker.	Union Grain.	Dry Brewers' Grains	Hominy.
1, ...	3	5,221.0	3.14	164.25	......	1,100.	1,550.	2,000.	......	180.	......	250.6	46.5	341.00	71.3	106.76	31.	142.6	1,313.	....	....	425.8	......	......
2, ...	3	4,743.6	3.12	151.02	......	860.	1,550.	2,000.	......	180.	......	250.6	46.5	624.20	71.3	106.70	31.	142.6	1,313.	....	....	142.0	......	......
3, ...	3	4,401.3	3.22	141.75	......	1,096.	4,290.	2,450.	......	......	......	102.4	......	169.00	140.3	155.80	61.	142.6	93.	238.0	31.0	....	......	......
4, ...	6	7,206.95	3.24	233.14	......	1,876.	4,290.	3,830.	......	180.	......	334.3	46.5	206.59	140.3	216.06	61.	142.6	93.	290.7	83.7	142.6	......	......
5, ...	5	5,773.0	4.14	239.03	61.	1,530.	......	......	915.	900.	705.	522.0	42.0	......	264.0	174.50	45.	46.0	......	....	....	....	587.0	764.0
6, ...	4	5,001.3	3.45	172.74	92.	1,240.	......	775.	2,155.	......	......	364.6	......	......	93.0	129.30	....	197.8	62.	....	....	....	135.8	509.7
7, ...	4	3,865.4	3.46	134.19	31.	1,210.	450.	......	......	1,200.	765.	335.0	82.0	......	......	120.00	45.	141.7	......	....	....	....	502.0	359.0
8, ...	3	3,929.3	3.42	134.63	61.	930.	......	......	2,155.	......	......	314.2	......	......	93.0	73.20	....	......	......	....	....	....	141.7	403.8
9, ...	3	1,557.5	3.65	56.90	31.	910.	450.	......	1,200.	......	390.	230.0	71.0	......	......	67.00	....	......	......	....	....	....	345.0	254.0
10, ...	3	5,128.0	2.72	139.73	62.	930.	......	......	1,705.	......	......	386.8	......	......	124.0	94.90	....	193.4	......	....	....	....	193.4	512.8
11, ...	3	4,100.2	3.27	134.00	......	910.	......	......	......	900.	705.	302.0	47.0	......	......	104.00	45.	......	......	....	....	....	454.0	326.0
12, ...	4	7,015.1	3.75	263.58	61.	1,240.	......	775.	2,155.	......	......	414.5	......	......	225.0	206.70	....	162.7	62.	....	....	....	220.7	728.0
13, ...	4	6,435.7	3.00	193.78	92.	1,240.	......	1,550.	1,830.	......	......	456.8	......	......	194.0	164.90	....	263.4	......	....	....	....	193.4	651.8
14, ...	3	5,038.7	3.18	160.57	61.	930.	......	......	2,635.	......	......	398.5	......	......	124.0	100.70	....	199.2	......	....	....	....	199.2	530.0
15, ...	4	7,708.9	3.20	247.01	92.	1,240.	......	......	2,635.	......	......	520.0	......	......	217.0	200.60	....	306.6	......	....	....	....	213.6	751.0
16, ...	4	5,181.9	3.25	167.01	92.	1,240.	......	775.	2,605.	......	......	407.2	......	......	124.0	151.20	....	234.7	62.	....	....	....	172.7	589.3
17, ...	4	7,684.5	3.37	259.21	92.	1,240.	......	775.	2,605.	......	......	506.5	......	......	124.0	193.70	....	299.7	93.	....	....	....	206.7	731.0
18, ...	4	6,770.1	3.19	215.87	92.	1,220.	......	775.	2,635.	......	......	483.5	......	......	124.0	185.70	....	284.2	85.	....	....	....	189.2	700.0
19, ...	5	5,832.2	4.65	271.32	31.	1,210.	450.	......	......	1,250.	765.	431.5	92.0	......	......	218.70	45.	60.7	......	....	....	....	658.7	625.0
Total,	71	102,546.15	3.39	3,479.73	951.	22,152.	13,030.	15,705.	25,230.	4,790.	3,450.	7,011.0	473.5	1,340.79	2,129.2	2,770.42	364.	2,969.5	3,176.	528.7	114.7	711.0	4,413.1	8,434.9
*Ave.,	5916	17,333.0	3.39	588.16	160.7	3,744.4	2,202.5	2,654.6	4,264.7	809.6	583.1	1,185.	80.03	226.6	358.2	408.2	61.5	501.9	536.8	89.3	19.3	120.1	745.9	1,425.7

*Average per cow.

Table XII

Ayrshire Records Showing Estimated Production and Feed Consumed

No. of Cow.	Months.	YIELD DURING PERIOD.			POUNDS OF FEED CONSUMED.													
		Milk, Lbs.	% Fat.	Lbs. Fat.	Pasture Days.	Hay.	Silage.	Roots.	Soiling Crops.	Bran.	Ground Oats.	Oil Meal.	Corn-meal.	Cottonseed Meal.	Gluten.	Beet Pulp.	Larro Feed.
1, ...	6	3,459.55	4.83	167.28	61.	825.0	2,150.	....	1,612.	383.9	383.9	101.70	174.3	233.20	135.1	348.0	....
2, ...	5	6,851.35	3.55	243.61	92.	515.	1,220.	....	1,612.	404.8	404.8	122.80	204.6	302.50	143.5	184.	....
3, ...	2	1,435.70	4.63	66.55	....	670.	1,530.	....	....	174.4	174.4	45.90	85.7	85.70	45.9	184.	....
4, ...	6	5,636.55	3.66	206.49	91.	825.	2,150.	....	1,240.	447.9	447.5	116.90	192.3	266.70	156.5	308.	....
5, ...	6	5,337.20	4.17	222.92	92.	825.	2,150.	....	1,612.	447.9	447.9	73.50	192.3	266.70	156.5	308.	....
6, ...	3	2,860.70	4.68	134.07	92.	....	....	....	1,612.	190.9	190.9	21.70	39.0	113.40	76.8	....	....
7, ...	4	3,485.90	3.48	121.47	61.	2,140.	610.	....	....	275.7	275.7	23.20	137.5	114.20	275.7	620.	....
8, ...	5	4,730.70	3.77	178.67	92.	1,230.	1,830.	....	930.	346.5	346.5	137.70	164.3	38.40	....	930.	....
9, ...	3	2,295.10	4.09	95.60	31.	920.	1,830.	....	....	173.7	173.7	63.20	40.0	23.20	127.2	310.	....
10, ...	2	1,328.10	3.24	43.02	....	610.	1,830.	....	....	103.5	103.5	50.00	50.0	....	103.5	....	....
11, ...	6	5,018.10	3.78	190.54	62.	1,220.	2,280.	....	930.	347.8	347.8	114.00	173.3	13.60	347.8	1,170.	....
12, ...	2	1,548.00	3.30	51.17	....	610.	1,830.	....	....	117.0	117.0	57.00	57.0	....	117.0	....	....
13, ...	2	1,644.60	4.66	75.68	....	610.	1,380.	....	....	118.3	118.3	59.30	59.3	....	118.3	240.	....
14, ...	3	2,435.80	3.71	89.42	....	910.	2,280.	....	....	193.3	193.3	96.80	96.8	....	193.3	240.	....
15, ...	2	1,851.60	5.13	95.07	....	610.	1,830.	....	....	137.2	132.7	65.00	65.0	....	132.7	....	....
16, ...	5	3,542.60	3.95	140.22	61.	920.	2,280.	....	930.	274.3	274.3	137.40	137.4	....	274.3	850.	....
17, ...	5	4,856.00	4.04	196.66	92.	920.	1,830.	....	930.	321.0	321.0	146.50	162.0	15.50	321.0	920.	....
18, ...	5	5,807.20	3.32	192.98	91.	920.	1,830.	....	930.	386.7	386.7	103.70	177.0	25.40	386.7	930.	....
19, ...	6	4,292.20	3.53	151.67	92.	980.	2,280.	....	....	322.8	322.8	125.40	150.5	34.10	322.8	920.	....
20, ...	5	4,338.00	4.75	206.42	92.	910.	1,350.	....	930.	352.6	352.6	139.80	153.1	13.60	....	1,170.	....
21, ...	5	4,564.0	3.36	153.44	92	910.	1,350.	....	930.	376.5	376.5	147.20	187.7	19.20	376.5	1,170.	....
22, ...	5	3,661.9	4.36	159.80	92.	920.	1,830.	....	930.	227.7	322.2	103.15	100.2	17.05	322.2	920.	....
23, ...	2	476.0	4.23	20.14	....	610.	1,830.	....	....	68.7	68.7	34.00	34.0	....	68.7	....	....
24, ...	4	3,301.9	3.74	126.05	61.	610.	450.	....	930.	195.4	195.4	85.40	92.6	6.30	195.4	1,160.	....
25, ...	4	3,101.7	4.38	135.97	92.	610.	450.	....	930.	210.3	210.3	98.40	106.0	11.00	210.3	1,160.	....

Table XII—Continued

Ayrshire Records Showing Estimated Production and Feed Consumed

No. of Cow.	Months.	YIELD DURING PERIOD. Milk, Lbs.	% Fat.	Lbs. Fat.	POUNDS OF FEED CONSUMED. Pasture Days.	Hay.	Silage.	Roots.	Soiling Crops.	Bran.	Ground Oats.	Oil Meal.	Corn-meal.	Cottonseed Meal.	Gluten.	Beet Pulp.	Larro Feed.
26, ...	8	3,115.0	3.22	100.38	92.	810.	....	....	930.	201.3	201.3	79.60	99.0	10.30	201.3	930.	....
27, ...	8	3,824.2	3.62	138.61	61.	300.	450.	....	....	235.5	235.5	118.20	118.2	....	235.5	850.	....
28, ...	12	14,047.8	4.36	631.58	....	2,150.	5,200.	3,515.	4,465.	780.6	780.6	258.20	....	522.40	780.6	1,313.	1,507.
29, ...	8	2,050.3	4.42	90.68	....	455.	1,220.	915.	310.	248.7	248.7	81.90	....	166.80	248.7	....	210.
30, ...	4	3,724.1	3.80	141.53	....	....	1,075.	....	3,225.	....	....	....	....	....	....	310.	1,494.
31, ...	8	4,215.0	3.72	157.08	....	455.	1,220.	915.	310.	394.2	394.2	129.40	....	261.80	394.2	....	210.
32, ...	6	5,713.1	4.84	276.72	....	915.	3,660.	3,300.	....	252.0	252.0	90.00	....	180.00	252.0	....	1,110.
Total, ..	137	125,438.85	4.00	5,021.49	1,502.0	25,415.0	58,205.0	8,705.0	26,228.0	8,711.10	8,800.7	3,079.95	3,317.1	2,750.85	6,720.0	17,445.	4,531.
*Ave., ..	11,416	10,987.98	4.00	439.86	139.45	2,235.02	4,660.56	762.52	2,297.49	763.06	770.91	269.79	202.09	240.94	588.64	1,520.23	396.89

* Average per cow for 12 months.

Table XIII

Brown Swiss Records Showing Estimated Production and Feed Consumed

No. of Cow.	Months.	YIELD DURING PERIOD.			POUNDS OF FEED CONSUMED.												
		Milk, Lbs.	% Fat.	Lbs. Fat.	Pasture Days.	Hay.	Silage.	Roots.	Soiling Crops.	Bran.	Ground Oats.	Oil Meal.	Corn and Cob Meal.	Corn Chop.	Brewers' Grains.	Corn-meal.	Gluten.
1, ...	12	7,615.45	4.74	361.46	153.	1,380.	5,790.	....	900.	2,452.8	910.1	402.9	123.6	58.80	406.8	599.5	482.36
2, ...	8	6,092.40	4.11	250.52	123.	1,626.	3,340.	288.	....	490.0	120.7	280.9	....	270.60	724.0	79.2	393.08
3, ...	5	3,651.10	4.34	158.48	30.	1,356.	2,480.	....	900.	706.4	244.0	61.0	....	....	379.0	337.0	170.60
4, ...	11	6,325.70	3.87	245.24	153.	2,250.	5,454.	....	600.	871.0	301.9	257.4	158.0	132.90	874.8	357.0	409.40
5, ...	6	4,380.90	4.52	198.32	123.	811.	1,629.	420.	....	256.2	132.8	263.9	....	242.90	572.0	....	307.68
6, ...	3	2,972.00	4.84	143.69	92.	....	....	....	....	....	106.9	177.0	....	106.90	284.7	....	124.60
7, ...	12	8,915.45	5.01	447.02	153.	3,004.	6,152.	....	900.	1,007.0	325.2	653.7	108.0	295.50	1,080.4	489.0	490.18
8, ...	2	395.30	5.51	21.80	30.	....	620.	....	900.	244.0	152.0	61.0	....	....	....	183.0	....
Total, ..	59	40,348.30	4.52	1,826.53	857.0	10,517.	25,465.	708.	4,200.	6,117.4	2,302.6	2,065.8	389.6	1,107.6	4,322.3	2,044.7	2,377.90
*Ave., ..	4,916	8,207.84	4.52	371.54	174.32	2,139.34	5,180.02	144.02	854.85	1,244.47	468.38	420.21	77.23	225.3	879.23	415.92	483.70

*Average per cow for 12 months.

Table XIV

Jersey Records. Showing Estimated Production and Feed Consumed

NO. OF COW.	Months.	YIELD DURING PERIOD. Milk, Lbs.	% Fat.	Lbs. Fat.	POUNDS OF FEED CONSUMED. Pasture Days.	Hay.	Silage.	Roots.	Corn Fodder.	Soiling Crops.	Stock Feed.	Bran.	Oil Meal.	Oats.
1,	5	3,014.25	6.69	201.82	61.	920.	2,418.	305.	....	620.	....	399.0	93.0	420.0
2,	5	4,536.15	4.95	224.02	62.	980.	2,418.	305.	....	620.	....	555.0	02.0	521.0
3,	5	5,505.25	5.21	287.36	61.	1,073.	2,418.	305.	....	620.	....	555.0	93.0	555.0
4,	3	3,434.90	4.84	166.30	62.	341.	868.	....	....	620.	....	307.0	61.0	207.0
5,	4	4,605.70	5.08	234.38	61.	763.	703.	....	....	620.	....	431.0	62.0	431.0
6,	6	4,564.90	5.41	247.29	61.	1,220.	3,168.	1,085.	....	620.	....	583.0	....	583.0
7,	5	4,141.55	5.09	211.28	61.	980.	2,418.	305.	....	620.	....	496.2	85.8	496.2
8,	11	7,103.60	4.23	300.78	61.	3,173.	3,706.	2,760.	600.	300.	....	167.1	127.5	....
9,	10	8,106.50	4.79	388.86	31.	2,317.	....	186.	465.	1,365.	....	445.0	111.1	98.0
10,	10	5,183.80	5.35	277.47	....	2,786.	2,495.	2,616.	300.	455.	....	224.4	115.2	12.4
11,	11	5,836.60	4.39	256.28	62.	....	2,495.	2,616.	455.	1,075.	....	332.0	....	70.7
12,	10	6,103.00	4.47	273.27	62.	2,424.	2,735.	2,616.	455.	775.	....	....	205.8	70.7
13,	8	2,043.70	5.07	103.70	62.	90.	....	....	....	2,935.	....	85.0	....	42.5
14,	7	5,054.40	5.38	272.24	93.	1,097.	590.	....	....	2,935.	....	331.8	106.1	70.4
15,	8	1,207.90	5.93	71.73	....	757.	1,130.	1,086.	....	600.	....	80.0	89.0	....
16,	11	6,027.60	5.06	305.67	61.	3,675.	3,450.	4,540.	300.	300.	....	152.1	206.9	....
17,	10	6,804.70	5.56	378.66	31.	2,567.	2,735.	2,078.	455.	300.	....	347.1	236.8	714.0
18,	11	7,490.50	4.32	324.24	62.	2,567.	2,735.	2,636.	455.	1,075.	....	370.6	153.1	70.7
19,	6	2,915.60	5.64	164.47	92.	1,530.	....	....	....	930.	....	604.8	171.1	....
20,	6	3,156.85	5.03	158.90	93.	1,530.	....	....	....	1,860.	....	604.8	171.1	....
21,	6	3,504.85	5.46	191.51	92.	1,530.	....	....	....	1,860.	....	652.7	186.4	....
22,	6	4,474.40	4.86	217.81	92.	1,530.	....	....	....	1,820.	....	640.3	183.3	....
23,	8	2,533.30	4.93	125.11	92.	930.	....	....	....	....	....	363.2	85.8	....
24,	6	5,637.20	4.47	251.99	92.	1,530.	....	....	....	930.	....	707.5	208.2	....
25,	2	1,418.20	5.38	76.33	62.	....	....	....	....	930.	....	148.8	87.2	....

Table XIV—Continued

Jersey Records. Showing Estimated Production and Feed Consumed

NO. OF COW.	Months.	YIELD DURING PERIOD.			POUNDS OF FEED CONSUMED.									
		Milk, Lbs.	% Fat.	Lbs. Fat.	Pasture Days.	Hay.	Silage.	Roots.	Corn Fodder.	Soiling Crops.	Stock Feed.	Bran.	Oil Meal.	Oats.
26,	2	1,663.10	4.98	82.79	62.					930.		186.0	40.4	
27,	6	3,504.20	5.24	183.80	92.	1,530.				930.		652.7	248.4	
28,	4	1,835.10	5.35	98.10	30.	1,530.						357.2	109.2	
29,	2	2,895.20	4.11	120.18	61.					1,370.		243.6	33.4	43.4
30,	5	5,878.55	4.79	281.56		1,625.	3,770.				62.	140.0	113.0	211.0
31,	8	6,480.00	5.22	338.38		2,235.	4,375.				41.	192.0	114.0	293.0
32,	8	6,338.85	4.85	307.60		2,235.	4,375.				41.	192.0	76.0	352.0
Total.	200	143,000.40	4.98	7,124.03	1,814.	45,465.	49,002.	23,439.0	3,485.0	28,015.	144.	11,547.8	3,618.8	5,271.6
*Average.	16.606	8,580.36	4.98	427.72	108.84	2,728.0	2,940.23	1,400.39	209.1	1,674.96	8.64	692.23	211.19	316.38

* Average per cow for 12 months.

Table XIV—Continued

Jersey Records. Showing Estimated Production and Feed Consumed

NO. OF COW.	Months.	POUNDS OF FEED CONSUMED.											
		Corn Meal.	Cottonseed Meal.	Corn and Cob Meal.	Gluten.	Alfalfa Meal.	Beet Pulp.	Brewers' Grains.	Distillers' Grains.	Unicorn.	Hominy.	Schumaker.	Ajax.
1,	5	309.0	184.0	....	....	....	....	....	....	....	....	....	....
2,	5	490.0	245.0	....	....	....	....	....	....	....	....	....	....
3,	5	530.5	307.0	....	....	....	....	....	....	....	....	....	....
4,	3	230.5	138.5	....	....	....	....	....	....	....	....	....	....
5,	4	366.0	304.0	....	....	....	....	....	....	....	....	....	....
6,	6	....	....	....	....	....	....	....	....	....	....	....	....
7,	5	405.2	202.6	....	....	....	....	....	....	....	....	....	....
8,	11	....	375.3	1,977.7	552.8	92.3	228.0	304.9	....	....	....	....	....
9,	10	98.6	100.8	900.8	710.9	385.1	981.0	197.5	30.0	....	....	....	....
10,	10	....	131.6	1,442.0	345.4	154.6	517.0	165.2	27.9	....	....	....	....
11,	11	70.7	114.5	879.1	433.1	268.4	545.0	179.3	48.8	77.5	....	....	....
12,	10	70.7	114.4	947.0	464.9	158.2	609.0	189.7	48.8	77.5	....	....	....
13,	3	42.5	42.5	85.0	85.0	....	276.0	42.5	....	341.0	....	....	....
14,	7	98.3	70.4	253.5	319.2	20.3	762.0	148.6	30.0	325.5	....	....	....
15,	3	....	52.4	548.4	104.9	53.9	....			....	....	....	....
16,	11	....	333.4	2,285.4	308.7	225.4	304.0	53.0	27.9	....	....	....	....
17,	10	71.4	142.3	1,203.2	483.5	192.3	576.0	365.7	....	....	....	....	....
18,	11	70.7	154.6	1,272.7	507.0	200.3	669.0	211.4	55.0	77.5	....	....	....
19,	6	....	....	....	151.2	....	295.8	228.7	55.0	....	236.8	368.0	....
20,	6	....	....	....	161.2	....	295.8	....	....	....	236.8	308.0	....
21,	6	....	....	....	164.1	....	295.8	....	....	....	284.7	368.0	....
22,	6	....	....	....	161.0	....	295.8	....	....	....	272.3	368.0	....
23,	3	....	....	....	85.8	....	295.8	....	....	....	327.5	363.2	....
24,	6	....	....	....	176.6	....	....	....	....	....	....	380.0	....
25,	2	....	....	....	37.2	....	....	....	....	....	....	148.8	....

Table XIV—Continued

Jersey Records. Showing Estimate d Production and Feed Consumed

NO. OF COW.	Months.	POUNDS OF FEED CONSUMED. Corn Meal.	Cottonseed Meal	Corn and Cob Meal.	Gluten.	Alfalfa Meal.	Beet Pulp.	Brewers' Grains.	Distillers' Grains.	Unicorn.	Hominy.	Schumaker.	Ajax.
26, ...	2	......	......	......	46.4	......	......	......	......	......	......	180.0	......
27, ...	6	......	......	......	226.1	......	295.8	......	......	......	284.7	368.0	......
28, ...	4	......	......	......	79.3	......	1,563.0	......	......	......	240.2	108.0	......
29, ...	2	197.1	36.5	......	152.5	......	......	......	......	......	......	......	......
30, ...	5	......	64.0	......	325.0	......	Dry 613.0	432.0	......	......	391.0	52.0	221.
31, ...	8	51.0	138.0	......	404.0	......	Dry 337.0	777.0	......	......	414.0	36.0	152.
32, ...	8	174.0	......	......	401.0	......	282.0	777.0	......	......	394.0	30.0	107.
Total, ...	200	3,375.2	3,251.8	11.855.7	6.969.8	1,750.8	10.096.8	4.071.6	323.4	899.0	3.091.0	3.150.0	540.0
*Average, ...	16.666	202.52	195.11	711.37	418.24	105.05	605.83	244.3	19.4	53.34	185.46	188.00	32.40

* Average per cow for 12 months.

Table XV

Guernsey Records. Showing Estimated Production and Feed Consumed

No. of Cow.	Months.	YIELD DURING PERIOD.			POUNDS OF FEED CONSUMED.													
		Milk, Lbs.	% Fat.	Lbs. Fat.	Hay.	Silage.	Roots.	Pasture Days.	Soiling Crops.	Oat Straw.	Oats.	Bran.	Wheat Middling.	Cottonseed Meal.	Corn-meal.	Dry Brewers' Grains.	Gluten.	Oil Meal.
1, ...	2	1,212.30	4.87	59.14	734.	1,525.	....	....	....	......	39.9	104.6	22.3	39.90	84.5	104.6	66.9	22.30
2, ...	5	4,836.10	4.70	227.59	1,284.	2,425.	....	62.	1,085.	......	158.1	315.7	33.7	210.40	316.0	239.7	146.3	50.70
3, ...	5	3,479.00	5.38	187.12	1,284.	2,425.	....	....	1,085.	......	175.2	281.8	33.7	161.80	305.3	196.0	131.3	51.70
4, ...	3	1,173.90	5.43	63.76	1,008.	....	....	30.	....	......	123.6	218.3	......	122.80	......	123.6	73.8	97.80
5, ...	3	1,376.00	4.60	63.31	1,608.	....	....	30.	....	......	131.6	235.3	......	133.80	......	131.6	78.8	105.80
6, ...	3	2,417.40	5.11	123.56	972.	....	420.	91.	....	......	273.0	273.0	204.2	91.00	204.2	......	136.5	91.00
7, ...	4	3,108.75	5.67	174.44	1,525.	....	....	....	....	......	366.0	366.0	276.3	123.00	276.3	......	186.5	123.00
8, ...	7	2,866.00	5.00	143.43	455.	2,720.	....	120.	....	......	......	257.7	......	265.40	......	......	359.2	36.88
9, ...	6	3,404.40	4.70	161.02	1,032.	3,294.	....	39.	....	......	......	494.7	......	114.20	214.0	......	419.2	35.70
10, ...	2	1,434.70	5.31	76.19	300.	1,200.	....	....	....	......	......	174.0	......	43.50	87.0	......	174.0	......
11, ...	2	1,205.40	6.48	78.14	....	600.	....	31.	....	......	......	31.0	......	35.50	102.0	......	91.0	35.50
12, ...	2	696.60	5.66	394.49	....	600.	....	31.	....	......	......	17.7	......	28.86	75.4	......	77.7	28.86
13, ...	9	4,240.95	4.81	204.18	912.	3,154.	....	31.	....	......	......	780.6	......	81.70	452.2	......	802.7	33.20
14, ...	2	660.30	4.90	32.36	....	600.	....	31.	....	......	......	12.04	......	81.30	56.8	......	57.0	81.30
15, ...	2	1,456.90	4.47	65.14	300.	1,200.	....	....	....	......	......	174.0	......	43.50	88.0	......	174.0	......
16, ...	5	3,323.30	4.38	145.89	972.	1,954.	....	....	....	......	......	551.2	......	45.50	227.6	......	551.2	......
17, ...	2	1,161.30	4.48	52.04	300.	1,200.	....	....	....	......	......	130.5	......	33.00	65.5	......	130.5	......
18, ...	2	1,637.40	5.16	84.49	732.	1,494.	....	8.	....	......	......	207.6	......	45.50	55.8	......	207.6	......
19, ...	6	5,943.75	4.21	250.43	1,504.	1,830.	610.	123.	....	......	268.0	344.9	......	116.60	......	......	178.2	147.90
20, ...	8	6,069.20	4.80	292.44	2,082.	4,555.	1,520.	154.	....	......	565.2	611.7	......	129.70	15.5	......	234.7	158.70
21, ...	2	745.00	6.93	51.70	548.	1,070.	610.	31.	....	......	88.5	73.0	......	30.50	15.5	......	58.0	30.50
22, ...	2	628.80	7.57	47.60	548.	1,670.	610.	31.	....	......	88.5	73.0	......	30.50	15.5	......	58.0	30.50
23, ...	8	6,104.70	5.25	320.81	2,142.	....	1,370.	....	....	......	344.2	417.8	......	181.00	12.4	......	295.0	169.00
24, ...	9	7,944.40	4.64	369.22	2,446.	5,015.	662.	123.	....	......	538.5	618.4	......	147.90	......	......	273.2	222.60
25, ...	4	2,283.00	5.04	114.75	1,044.	....	....	123.	....	......	139.1	185.6	......	80.40	......	......	141.6	80.40

Table XV—Continued

Guernsey Records. Showing Estimated Production and Feed Consumed

No. of Cow.	Months.	Yield During Period. Milk. Lbs.	% Fat.	Lbs. Fat.	Pounds of Feed Consumed. Hay.	Silage.	Roots.	Pasture Days.	Soiling Crops.	Oat Straw.	Oats.	Bran.	Wheat Middling.	Cottonseed Meal.	Corn-meal.	Dry Brewers' Grains.	Gluten.	Oil Meal.
26, ...	4	6,044.90	4.40	266.03	1,044.	....	....	123.	....	....	295.7	416.6	....	110.70	....	....	181.0	141.70
27, ...	5	2,878.55	5.93	170.59	1,400.	4,855.	1,799.	....	....	....	262.0	243.4	....	94.20	18.6	....	202.1	94.20
28, ...	7	5,003.85	6.05	300.53	1,950.	6,685.	3,293.	31.	....	....	377.7	355.3	....	157.90	46.5	....	253.5	170.60
29, ...	6	6,073.10	4.53	275.43	739.	....	1,220.	....	2,915.	....	....	....	....	....	....	....	....	....
30, ...	12	7,272.60	6.17	459.08	1,449.	5,200.	3,515.	....	3,070.	....	317.4	317.4	....	211.60	....	....	317.4	105.80
31, ...	2	1,472.80	6.20	91.33	305.	620.	620.	....	....	....	60.0	60.0	....	40.00	....	....	60.0	20.00
32, ...	2	1,890.00	5.68	107.24	305.	1,220.	915.	....	310.	....	183.0	183.0	....	122.00	....	....	183.0	61.00
33, ...	0	9,516.70	5.61	534.79	1,388.	3,460.	4,405.	92.	9,470.	....	305.8	790.9	137.1	377.40	376.6	....	....	300.80
34, ...	4	5,388.20	4.12	222.10	000.	....	....	03.	5,870.	....	380.2	380.2	225.2	....	225.2	....	109.5	92.90
35, ...	7	8,878.30	5.44	483.36	660.	2,410.	1,800.	....	6,810.	....	588.1	588.1	168.7	306.60	206.5	....	....	211.10
36, ...	2	814.55	4.92	40.10	186.	....	....	60.	....	....	....	....	....	....	....	....	....	....
37, ...	4	2,317.10	5.91	136.90	734.	1,370.	2,196.	....	....	....	....	....	....	....	....	....	....	....
38, ...	9	9,479.50	4.81	456.18	1,871.	4,120.	3,142.	153.	1,302.	....	83.7	1,054.0	....	68.2	90.2	....	....	83.7
39, ...	2	1,381.00	5.27	72.82	620.	1,085.	....	62.	1,705.	....	93.0	145.7	....	37.2	52.7	....	....	52.7
40, ...	9	5,723.35	5.84	334.31	1,747.	3,582.	3,912.	61.	....	....	....	....	....	....	....	....	....	....
41, ...	7	2,971.35	5.12	152.21	1,592.	3,210.	3,540.	61.	....	....	....	....	....	....	....	....	....	....
42, ...	4	2,824.80	4.74	134.06	1,096.	2,590.	3,792.	....	....	....	....	....	....	....	....	....	....	....
43, ...	2	1,562.46	5.53	86.45	620.	1,085.	....	62.	1,550.	....	93.0	145.7	....	52.7	114.7	....	....	114.7
44, ...	7	10,119.95	4.01	405.83	1,685.	2,114.	1,006.	....	1,302.	....	21.7	37.2	....	15.5	31.0	....	....	31.0
45, ...	6	1,706.90	5.33	95.92	1,273.	3,655.	870.	61.	....	....	....	44.6	....	....	22.3	....	223.0	....
46, ...	3	1,147.40	5.23	59.95	545.	1,830.	....	61.	....	....	....	91.2	....	....	34.0	....	34.0	91.2
47, ...	2	565.75	5.68	32.17	305.	930.	....	61.	....	....	....	91.2	....	....	34.0	....	34.0	91.2
48, ...	7	2,078.35	5.84	121.42	1,431.	3,060.	1,800.	91.	....	....	....	92.1	....	....	47.3	....	46.8	....
49, ...	2	780.50	6.36	49.70	315.	930.	....	....	....	....	....	....	....	....	....	....	....	....
50, ...	6	2,123.50	5.83	123.82	1,273.	4,270.	870.	61.	....	....	....	44.5	....	....	22.3	....	22.3	....

Table XV—Continued

Guernsey Records. Showing Estimated Production and Feed Consumed

No. of Cow.	Months.	YIELD DURING PERIOD.			POUNDS OF FEED CONSUMED.													
		Milk, Lbs.	% Fat.	Lbs. Fat.	Hay.	Silage.	Roots.	Pasture Days.	Soiling Crops.	Oat Straw.	Oats.	Bran.	Wheat Middlings.	Cottonseed Meal.	Corn-meal.	Dry Brewers' Grains.	Gluten.	Oil Meal.
51, ...	7	3,917.15	5.45	213.81	1,521.	4,890.	1,800.	61.	....	......	....	110.0	....	....	55.2	....	55.2	....
52, ...	11	10,449.65	4.94	517.12	1,939.	6,690.	1,200.	114.	700.	......	....	577.2	....	....	138.0	....	229.5	546.2
53, ...	7	3,905.25	5.03	196.56	1,521.	4,890.	1,800.	....	....	......	....	110.0	....	....	55.2	....	55.2	....
54, ...	12	12,753.60	4.09	521.64	2,353.	7,470.	....	....	1,000.	......	31.0	217.0	....	....	....	....	60.0	217.0
55, ...	7	7,870.50	4.78	376.82	1,048.	2,465.	1,900.	113.	700.	......	....	522.0	....	....	....	....	278.0	589.0
56, ...	2	1,412.10	5.07	71.61	548.	....	310.	....	310.	......	44.5	44.5	....	....	....	34.0	56.9	56.9
57, ...	7	6,308.55	4.35	275.02	2,250.	2,560.	....	....	3,128.	......	373.2	397.6	....	125.4	....	188.1	265.4	232.3
58, ...	2	1,165.90	5.79	67.44	420.	....	620.	61.	....	......	45.7	45.7	....	....	....	37.6	30.5	30.5
59, ...	8	4,749.05	5.98	284.38	2,248.	2,916.	3,488.	....	1,674.	......	330.5	355.1	....	133.4	....	148.5	257.4	221.1
60, ...	12	10,282.40	4.88	502.04	3,752.	4,747.	3,808.	....	4,046.	......	617.8	645.3	....	191.8	....	524.4	465.8	444.4
61, ...	5	5,365.30	4.73	253.98	1,106.	3,488.	750.	....	1,225.	......	269.2	260.2	....	128.7	....	342.7	208.0	236.2
62, ...	8	6,547.20	5.52	361.58	2,248.	2,420.	4,468.	61.	1,798.	......	362.2	383.6	....	154.8	....	216.0	271.1	220.7
63, ...	11	6,853.30	5.16	353.24	2,776.	4,820.	3,518.	30.	2,096.	......	465.2	547.9	....	160.2	....	392.0	386.5	314.3
64, ...	9	7,119.80	5.27	376.07	2,800.	3,304.	3,068.	....	2,582.	......	513.9	541.4	....	181.8	....	325.2	375.2	320.4
65, ...	8	5,193.80	4.36	226.53	1,924.	4,448.	3,298.	....	1,240.	......	373.9	347.9	....	194.8	....	308.7	285.3	251.1
66, ...	12	9,736.60	4.96	483.05	1,923.	5,065.	3,010.	122.	2,353.	455.	236.8	754.3	380.1	....	458.8	31.0	407.8	137.0
67, ...	8	3,777.40	5.99	226.57	1,708.	5,505.	1,650.	....	998.	300.	98.5	392.4	133.9	....	220.9	24.0	401.5	60.0
68, ...	4	2,423.60	4.59	111.47	792.	850.	854.	30.	930.	......	46.7	140.2	....	....	10.3	....	....	46.7
69, ...	6	6,023.20	4.55	274.59	1,858.	1,718.	992.	....	....	......	56.2	184.0	....	....	56.2	....	....	56.2
70, ...	7	6,936.40	4.87	338.10	1,788.	1,770.	1,722.	....	....	......	68.2	220.0	....	....	56.2	....	....	68.2
71, ...	4	2,465.50	5.07	147.42	792.	850.	854.	30.	930.	......	46.7	140.2	....	....	10.3	....	....	46.7
72, ...	10	11,775.00	4.19	493.88	2,218.	3,273.	1,412.	123.	1,302.	......	102.0	324.4	....	....	46.0	....	....	102.0
73, ...	10	10,330.80	4.56	465.54	2,218.	3,333.	1,412.	123.	1,302.	......	102.0	324.4	....	....	46.9	....	....	102.0
74, ...	8	2,004.70	4.86	97.43	544.	420.	420.	30.	930.	......	36.4	100.2	....	....	....	....	....	36.4
75, ...	10	9,151.80	4.96	454.02	2,218.	2,028.	1,412.	123.	1,302.	......	102.0	324.4	....	....	65.2	....	....	102.0

Table XV—Continued

Guernsey Records. Showing Estimated Production and Feed Consumed

No. of Cow.	Months.*	YIELD DURING PERIOD.			POUNDS OF FEED CONSUMED.														
		Milk, Lbs.	% Fat.	Lbs. Fat.	Hay.	Silage.	Roots.	Pasture Days.	Soiling Crops.	Oat Straw.	Oats.	Bran.	Wheat Middling.	Cottonseed Meal.	Corn-meal.	Dry Brewers' Grains.	Gluten.	Oil Meal.
76,	9	9,812.90	4.95	486.42	1,594.	2,229.	420.	122.	2,232.		97.8	275.6			30.0			97.8
77,	10	11,469.90	4.14	475.64	2,218.	3,271.	1,412.	123.	1,302.		102.0	324.4			63.2			102.0
78,	11	7,693.00	4.85	373.55	2,342.	2,912.	1,970.	92.	1,612.		114.7	362.6			65.5			114.7
79,	5	3,324.20	5.76	191.59	1,102.	1,160.	1,412.	30.	930.		56.0	171.2			19.6			56.0
80,	8	9,870.70	4.50	444.82	1,980.	2,431.	1,581.	31.	682.		67.6	221.2			55.2			67.6
81,	9	10,262.70	4.32	464.66	1,790.	2,307.	1,115.	122.	1,302.		92.0	294.4			55.2			92.0
82,	2	1,077.30	4.84	52.20	748.	1,240.												
83,	4	3,011.50	4.81	144.93	792.	668.	854.	30.	930.		46.7	140.2			10.3			46.7
84,	3	2,812.00	4.49	126.44	920.	674.		31.			27.6	92.0			27.6			27.6
85,	2	2,349.80	4.07	95.73		651.		62.	1,302.		24.8	74.4						24.8
86,	5	5,367.30	4.74	253.68	1,050.	1,563.		92.	682.		36.6	122.0			36.6			36.0
87,	4	2,748.00	5.02	138.13	702.	790.	854.	30.	930.		46.7	140.2			10.3			46.7
88,	5	5,769.00	4.19	242.88	1,588.	1,092.	558.				45.6	152.0			45.6			45.6
89,	7	7,030.70	4.22	296.82	1,956.	1,526.	992.	30.			55.9	183.0			55.9			46.9
90,	5	4,624.60	4.13	191.00	1,588.	1,156.	310.	31.			45.6	152.0			45.6			45.6
91,	5	4,681.90	4.71	220.60	1,588.	1,218.	310.				45.6	152.0			45.6			45.6
92,	6	5,345.20	4.72	252.35	1,050.	1,873.		123.	1,302.		61.4	196.4			36.6			61.4
93,	6	5,307.50	4.52	240.77	1,050.	1,193.		123.	1,302.		61.4	196.4			36.6			61.4
94,	6	6,263.00	4.97	311.57	1,050.	1,873.		92.	1,302.		61.4	196.4			36.6			61.4
95,	6	5,932.40	4.90	290.78	1,050.	1,873.		123.	1,302.		52.1	196.4			36.0			61.4
96,	8	8,409.00	4.29	363.76	1,294.	1,689.		122.	2,232.		85.8	269.6			36.6			85.8
97,	7	7,954.50	4.81	383.11	2,134.	2,014.	1,412.				68.2	220.0			56.2			68.2
98,	6	4,580.70	5.41	248.15	1,102.	1,008.	1,412.	30.	930.		108.9	249.5		92.5	123.3			108.9
99,	5	5,100.00	4.76	243.31	1,550.	1,344.	558.				46.9	153.0			27.3			46.9
100,	6	4,848.00	4.37	212.33	1,450.	1,390.	1,402.	30.	930.		64.7	200.2			28.3			64.7
101,	8	5,430.60	5.08	276.32	1,708.	1,710.	558.	123.	1,302.		79.4	256.4			45.3			79.4
Total,	583	479,197.8	4.94	23,707.67	120,620.0	218,824.	106,383.0	4,835.	89,556.0	755.0	12,577.7	25,059.64	1,615.2	6,277.76	6,355.7	3,367.7	10,918.3	9,343.42
*Ave.,..	48.583	9,884.07	4.94	487.98	2,668.01	4,504.12	2,189.73	99.5	1,843.36	15.54	258.89	515.82	33.24	120.21	130.83	69.31	224.73	192.31

* Average per cow for 12 months.

Table XV—Continued

Guernsey Records. Showing Estimated Production and Feed Consumed

No. of Cow.	Months.	Beet Pulp.	Corn and Cob Meal.	Corn Bran.	Cerealine.	Indian Meal.	Union Grains.	Unicorn.	Ajax.	Hominy.	Schumaker.	Larro Feed.	Molasses.	Molasses Feed.	Ajax Flakes.	Extra Vim Meal.	Soybean Meal.	Distillers' Grains.	Alfalfa Meal.
		POUNDS OF FEED CONSUMED.																	
1,	2																		
2,	5	225.4																	
3,	5	120.0																	
4,	8		156.6																
5,	8		167.0																
6,	3																		
7,	4	90.0																	
8,	7	135.5		35.4	187.0														
9,	6	151.5		53.9	208.0	48.0													
10,	2	89.5																	
11,	2			62.0	100.0														
12,	2			35.4	100.0														
13,	9	151.5		177.0	77.5														
14,	2			209.0	75.0														
15,	2	80.5																	
16,	5	62.0				48.0													
17,	2	80.5																	
18,	2	62.0				48.0													
19,	6	552.0					455.80	44.3	208.6	117.1									
20,	8	471.4					321.50	62.	251.3	95.6	62.0								
21,	2						54.90		58.0	46.0									
22,	2						54.90		58.0	46.0									
23,	3	501.4					124.45		275.6	113.4	62.0								
24,	9	887.0		104.4			764.70		153.2	65.7									
25,	4	270.0					314.60	44.3	116.9	36.6									

Table XV—Continued

Guernsey Records. Showing Estimated Production and Feed Consumed

No. of Cow.	Months.	POUNDS OF FEED CONSUMED.																	
		Beet Pulp.	Corn and Cob Meal.	Corn Bran.	Cerealine.	Indian Meal.	Union Grains.	Unicorn.	Ajax.	Hominy.	Schumaker.	Larro Feed.	Molasses.	Molasses Feed.	Ajax Flakes.	Extra Vim Meal.	Soybean Meal.	Distillers' Grains.	Alfalfa Meal.
26,	4	461.0					420.00		140.7	27.0									
27,	5	310.2					255.10		147.5	146.9									
28,	7	555.2					614.20		211.1	144.1									
29,	6	310.0										2,208.0							
30,	12	520.0										1,685.0							
31,	2											520.0							
32,	2																		
33,	9	1,431.0											87.5	40.3	1,084.4	8.58			
34,	4	493.0							884.7				15.5		24.8	88.9			
35,	7	855.0											76.5	21.7		87.9			
36,	2							397.0											
37,	4							1,158.0				2,087.5							
38,	9	434.0						868.0	1,147.0								15.5		
39,	2	341.0							167.4										
40,	9	186.0						1,892.0				982.0							
41,	7	186.0						1,346.0				448.0							
42,	4							1,104.0				300.0							
43,	2	310.0							164.3								15.5		
44,	7	186.0							46.5			2,980.5							
45,	6							362.0	55.7			546.0							
46,	3							180.0	116.6										
47,	2							372.0	116.6			786.0							
48,	7								115.2										
49,	2							427.0											
50,	6							492.0	55.7			728.0							

Table XV—Continued

Guernsey Records. Showing Estimated Production and Feed Consumed

No. of Cow.	Months.	Beet Pulp.	Corn and Cob Meal.	Corn Bran.	Cerealine.	Indian Meal.	Union Grains.	Unicorn.	Ajax.	Hominy.	Schumaker.	Larro Feed.	Molasses.	Molasses Feed.	Ajax Flakes.	Extra Vim Meal.	Soybean Meal.	Distillers' Grains.	Alfalfa Meal.
		POUNDS OF FEED CONSUMED.																	
51, ...	7	....	....	....	....	....	....	647.0	137.7	....	....	790.0	....	....	....	....	....	....	....
52, ...	11	490.0	....	....	....	....	....	....	533.7	....	....	2,352.0	....	....	....	....	....	58.0	....
53, ...	7	....	....	....	....	....	....	492.0	137.7	....	....	608.0	....	....	....	....	....	....	....
54, ...	12	769.0	....	....	....	....	....	1,498.0	....	....	....	1,135.0	....	....	201.5	....	....	....	....
55, ...	7	454.0	....	....	....	....	....	....	331.2	....	....	1,518.0	....	....	....	....	....	....	93.0
56, ...	2	194.4	....	....	....	....	226.7	183.0	....	56.9	....	....	....	....	....	....	....	84.1	....
57, ...	7	272.0	30.0	....	....	....	993.2	273.0	....	68.1	....	....	....	....	....	....	....	48.4	....
58, ...	2	152.0	....	....	....	....	251.5	183.0	....	30.5	....	....	....	....	....	....	....	....	....
59, ...	8	257.5	24.0	....	....	....	840.2	279.2	....	56.9	....	....	....	....	....	....	....	37.2	....
60, ...	12	890.0	....	....	....	....	1,310.7	301.5	....	252.7	....	....	....	....	....	....	....	111.6	....
61, ...	5	446.0	....	....	....	....	....	....	....	215.2	....	....	....	....	....	....	....	....	....
62, ...	8	233.8	24.0	....	....	....	941.0	252.0	....	84.5	....	....	....	....	....	....	....	21.7	....
63, ...	11	473.0	24.0	....	....	....	922.7	252.0	....	125.1	....	....	....	....	....	....	....	34.1	....
64, ...	9	405.0	30.0	....	....	....	1,031.0	252.0	....	68.1	....	....	....	....	....	....	....	43.4	....
65, ...	8	152.5	....	....	....	....	....	....	....	91.5	340.8	....	....	....	....	....	....	....	....
66, ...	12	60.0	159.6	....	....	....	....	....	316.6	....	....	....	....	....	....	....	....	45.0	....
67, ...	8	109.8	37.2	....	....	....	....	....	186.0	....	....	....	....	....	....	....	....	27.9	....
68, ...	4	520.0	....	....	....	....	945.0	....	....	....	....	....	....	....	....	....	....	....	....
69, ...	6	730.0	....	....	....	....	1,474.0	....	....	....	....	....	....	....	....	....	....	....	....
70, ...	7	581.0	....	....	....	....	1,651.0	....	....	....	....	....	....	....	....	....	....	....	....
71, ...	4	312.0	....	....	....	....	946.0	....	....	....	....	....	....	....	....	....	....	....	....
72, ...	10	1,104.0	18.3	....	....	....	2,601.0	....	....	....	....	....	....	....	....	....	....	....	....
73, ...	10	1,104.0	18.3	....	....	....	2,756.0	....	....	....	....	....	....	....	....	....	....	....	....
74, ...	8	304.0	....	....	....	....	606.0	....	....	....	....	....	....	....	....	....	....	....	....
75, ...	10	980.0	....	....	....	....	2,326.0	....	....	....	....	....	....	....	....	....	....	....	....

Table XV—Continued

Guernsey Records. Showing Estimated Production and Feed Consumed

No. of Cow.	Months.	POUNDS OF FEED CONSUMED.																	
		Beet Pulp.	Corn and Cob Meal.	Corn Bran.	Cereline.	Indian Meal.	Union Grains.	Unicorn.	Ajax.	Hominy.	Schumaker.	Larro Feed.	Molasses.	Molasses Feed.	Ajax Flakes.	Extra Vim Meal.	Soybean Meal.	Distillers' Grains.	Alfalfa Meal.
76. *	9	889.0					2,230.0												
77.	10	1,104.0					3,847.0												
78.	11	980.0					2,089.0												
79.	5	614.0					1,132.0												
80.	8	1,015.0					2,121.0												
81.	9	1,132.0					2,178.0												
82.	2						434.0												
83.	4	489.0					885.0												
84.	8	184.0					612.0												
85.	2	217.0					434.0												
86.	5	612.0					1,224.0												
87.	4	397.0					823.0												
88.	5	516.0					1,063.0												
89.	7	699.0					1,643.0												
90.	5	430.0					1,125.0												
91.	5	546.0					1,094.0												
92.	6	730.0					1,626.0												
93.	6	648.0					1,442.0												
94.	6	736.0					1,503.0												
95.	6	736.0					1,534.0												
96.	8	949.0					1,777.0												
97.	7	736.0					1,682.0		148.7										
98.	6	428.0					798.0												
99.	5	581.0					1,315.0												
100.	6	736.0					1,396.0												
101.	8	673.0					1,529.0												
Total.	583	38,615.1	689.6	738.0	747.5	144.0	60,744.15	13,361.8	6,282.2	1,837.0	464.8	19,674.0	179.5	62.0	1,310.7	262.6	31.0	456.4	[illegible]
*Ave.	48.583	794.84	14.19	15.19	15.39	2.96	1,250.31	275.02	129.3	37.82	9.56	404.95	3.69	1.27	26.97	5.40	0.63	9.39	1.91

* Average per cow for 12 months.

Table XVI

Summary of Seven-day and Thirty-day Holstein Records

Totals

	Lbs. Milk.	% Fat.	Lbs. Fat.	Value of Milk @ $0.05 per Qt.	Value of Butterfat @ $0.50 per Lb.	Cost of Roughage.	Cost of Grain.	Total Cost.	Profit Over Feed @ $0.05 per Qt.	Profit @ $0.50 per Lb. Fat.
Seven-day, ...	87,002.1	3.77	3,282.37	$1,953.50	$1,641.19	$401.54	$454.72	$856.26	$1,097.24	$784.91
Thirty-day, ...	59,752.3	3.83	2,291.37	1,389.59	1,145.69	174.69	298.52	473.21	916.38	672.48

Averages

	Lbs. Milk.	% Fat.	Lbs. Fat.	Value of Milk @ $0.05 per Qt.	Value of Butterfat @ $0.50 per Lb.	Cost of Roughage.	Cost of Grain.	Total Cost.	Profit Over Feed @ $0.05 per Qt.	Profit @ $0.50 per Lb. Fat.
Seven-day, ...	410.39	3.77	15.47	9.50	7.74	1.89	2.14	4.03	5.47	3.71
Thirty-day, ...	2,060.42	3.83	78.91	47.92	145.17	5.79	10.20	16.08	31.84	39.46

Table XVII

Average Production, Feed Cost and Profit Over Feed Cost per Cow

BREED.	Lbs. Milk.	% Fat.	Lbs. Fat.	Value of Milk @ $0.05 per Qt.	Value of Butterfat @ $0.50 per Lb.	Cost of Roughage.	Cost of Grain.	Total Cost.	Profit Over Feed @ $0.05 per Qt.	Profit @ $0.50 per Lb. Fat.
Guernsey, ...	9,884.07	4.94	487.98	$229.85	$243.99	$55.20	$72.85	$128.05	$101.80	$115.94
Jersey, ...	8,580.36	4.98	427.72	199.50	213.86	49.56	67.03	116.59	82.91	96.27
Ayrshire, ...	10,987.98	4.00	439.86	255.50	219.93	49.68	76.04	125.72	129.78	94.21
Brown Swiss, ...	8,207.84	4.52	371.54	190.85	185.77	46.23	64.19	110.42	80.43	75.35
Holstein, Semi-Official, ...	17,333.6	3.39	588.16	403.11	294.08	76.25	93.10	169.35	233.76	124.78

Following is a list of those who have successfully passed the testers' license examination and who have been granted a testers' certificate:

John R. Ashton, Belle Mead, N. J.; O. D. Benham, Sussex, N. J.; A. W. Case, Papakating, N. J.; J. Herbert Childs, Lyons, N. J.; Manly E. Clark, Sussex, N. J.; T. E. Clark, Sergeantsville, N. J.; E. W. Compton, Flemington, N. J.; W. D. Dotterer, Princeton, N. J.; Gustave Erhler, Lyons, N J.; E. F. Fortin, Philadelphia; E. F. Ferguson, Sussex, N. J.; Perry S. Fox, Trenton, N. J.; Wm. Graham, Huntsville, N. J.; D. C. Hagerman, Port Murray, N. J.; John H. Hammell, Branchville, N. J.; Thos. Hilton, Port Jervis, N. Y.; Lawrence Isaacs, Philadelphia; Frank C. Kerwin, Glenwood, N. J.; C. Sidney Leete, Newark, N. J.; L. W. Long, Newark, N. J.; F. W. Longwell, Blairstown, N. J.; Stephen H. Mars, Huntsville, N. J.; Ernest Morris, Papakating, N. J.; C. M. Miller, Woodstown, N. J.; F. A. Peabody, Readington, N. J.; H. A. Peterman, Cherryville, N J.; Joseph Roberts, Philadelphia; Geo. W. Struble, Sussex, N. J.; Harry Snover, Baleville, N. J.; I. F. Tarpine, Daretown, N. J.; Edwin Theetge, Hamburg, N. J.; Percy H. Titman, Stillwater, N. J.; Geo. W. Van Nest, Branchville, N. J.; Seward M. Wilcox, Reaville, N. J.

Inspection of Glassware

As provided by the law regulating the weighing, testing and purchasing of milk and cream (Chapter 31, Laws of 1916), all glassware used in the Babcock test in the State of New Jersey must be examined and stamped by this department.

The following table shows the results of the inspection of Babcock test glassware for the first two months after the law had gone into effect:

Kind of Glassware.	*No. of Pieces.*	*Number Incorrect.*	*Per cent Incorrect.*
Milk test bottles,	1827	9	0.49
Cream test bottles,	130	4	3.07
Pipettes,	100	2	2.00
Acid measures,	62	0	0.00
	2119	15	0.70

REPORT OF THE DEPARTMENT OF SEED ANALYSIS

Department of Seed Analysis

JOHN P. HELYAR, M.SC., *Seed Analyst.*
*A. C. FOSTER, B.SC., *Assistant Seed Analyst.*
†HOMER E. CARNEY, A.B., *Assistant Seed Analyst.*
‡MISS NEVEDA S. EVANS, M.A., *Assistant Seed Analyst.*

*Resigned January 1, 1916.
†Resigned August 31, 1916.
‡Appointed September 1, 1916.

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Report of the Department of Seed Analysis

John P. Helyar

I

INTRODUCTION

During the year the Seed Laboratory has continued in its function of studying the quality of seed used by the New Jersey farmers. This study has been based, in part, on the analysis of samples submitted by residents, who have received reports of such tests for their individual use. Official or inspection samples have been collected under the direction of the State seed analyst. The information revealed in the analysis of these official samples will be made public information in the form of a bulletin now ready for publication. Advice as to identity and treatment of weed plants submitted has been given. Further observations have been made with respect to alfalfa strains and are herein reported.

Changes in Staff

Mr. A. C. Foster and Mr. H. E. Carney, who began the fiscal year as graduate students on half-time basis in the Seed Laboratory have resigned, the former January 1, 1916, and the latter on September 1, 1916. These vacancies have been filled by the appointment of Miss Nevada S. Evans as Assistant Seed Analyst on full-time basis. Miss Evans is a graduate of the University of Minnesota and has wide experience in seed analytical work, having engaged in this for a large seed firm, and previous to coming to this laboratory she was employed at the North Dakota Experiment Station as seed analyst.

Publications

The following are the subjects of publications prepared by the State Seed Analyst during the year:

Results of Seed Inspection, 1915–1916. Station Bulletin.
The New Jersey Seed Law. Station Circular 59.
Weed Control. Station Circular 60.

II

STATISTICS OF OFFICIAL SAMPLES

During the fiscal year 294 official samples have been collected and analyzed. The kind and number of each is as follows: alsike clover, 1; crimson clover, 29; timothy, 1; lawn grass, 2; beans, 48; lima beans, 48; beets, 10; cabbage, 3; carrot, 2; sweet corn, 36; cucumber, 3; kale, 1; lettuce, 5; muskmelon, 2; onion, 3; parsnip, 1; peas, 91; pepper, 2; spinach, 1; radish, 5; tomato, 4; turnip, 2; watermelon, 1.

The majority of these are samples of vegetable seeds collected from bulk lots offered for sale this season. Detailed results are published in a forthcoming bulletin as provided by the Seed Law.

III

STATISTICS OF UNOFFICIAL SAMPLES

During the year 576 unofficial samples have been tested, representing 57 different kinds of seeds. The following tests were made, 34 samples for purity test only; 228 samples for germination test only; 308 samples for both purity and germination test and 6 samples for special test, the total number of tests of all kinds being 884.

The number of samples of each kind is as follows: alfalfa 99; alsike, 33; crimson clover, 50; red clover, 90; sweet clover, 6; white clover, 9; timothy, 31; red top, 4; all other grasses, 7; lawn grass mixtures, 7; cowpeas, 14; vetch, 15; carrot, 5; corn, 6; lettuce, 8; peas, 22; pepper, 7; radish, 5; spinach, 18; tomato, 11; turnip, 5; other vegetables, 39; oats, 24; other cereals, 13.

The following shows the source according to counties, and the same information for the previous year is offered for comparison:

	1916.	*1915.*
Atlantic,	6	2
Bergen,	3	20
Burlington,	30	77
Camden,	124	110
Cape May,	1	0
Cumberland,	11	27
Essex,	2	15

Gloucester,	2	7
Hudson,	0	1
Hunterdon,	21	19
Mercer,	31	28
Middlesex,	85	51
Monmouth,	14	4
Morris,	24	9
Ocean,	4	0
Passaic,	1	11
Salem,	29	29
Somerset,	14	29
Sussex,	4	14
Union,	123	39
Warren,	14	3

That certain counties run much higher than others is due to the fact that seedsmen residing therein have submitted a considerable number of samples throughout the year. Considering this, the general impression is that the farmers are not using the Seed Laboratory as extensively as conditions warrant. It is not probable that they are making their own tests, but rather that they are buying on the basis of past experience or least effort.

The highest number of samples received at any one period determines, to a certain extent, the size of the analytical force. Seed information is usually needed at short notice, and the force necessary to suppy this need might be much greater than it is necessary to carry throughout the year. While this is the case in some laboratories, the distribution of samples as here shown is such that no unusual load is carried for any length of time with the present demand for service.

	1916.	*1915.*
November,	5	9
December,	14	19
January,	88	53
February,	75	73
March,	90	85
April,	31	30
May,	45	25
June,	35	41
July,	63	39
August,	76	36
September,	33	44
October,	21	35

The slack periods of April, May and June and of October, November and December afford an opportunity to give attention to official samples.

IV

QUALITY OF UNOFFICIAL SAMPLES

Alfalfa. Of the samples of alfalfa tested, only about 4 per cent were Turkestan seed as against 20 per cent of this variety last year. The majority of the samples were of high purity. On account of hards seeds present, the germination, in many cases, was low, and there would have been a decided gain in scarifying such seed. No doubt this treatment will become much more common since a machine has been developed to do this economically and effectively.

Alsike clover. Samples of good average quality. Seeds of Canada thistle in one sample.

Crimson clover. The germination of some samples ran very low and the use of such seed is questionable. Seed situation very acute this past season, supply short, prices high and much old seed offered. This seed deteriorates readily and should be purchased and sown only on germination test.

Red clover. The majority of the samples received indicated the seed to be of European origin despite the fact that statements as to local origin accompanied some of the samples. Very little straight American seed offered this season, owing to unfavorable season of 1915. Average quality of samples good.

White clover. Majority of samples of good quality. A few, however, carrying a large per cent of alsike. The difference in price of these two seeds is too great to tolerate any quantity of this without commensurate reduction.

Timothy. Samples of good quality. No particular comment.

Vegetable seeds. Beans, peas, corn, etc., for the most part show satisfactory test. Lettuce low. One sample of spinach, representing a lot of 10 bushels, germinated 33.5 per cent. The grower failed to get satisfactory results with sowings of this seed and submitted sample. The dealer is protected by his non-warranty clause. Where is the protection for the grower whose loss is many times the cost of the seed? Will it not pay to test or have tested before sowing?

V

WEED CONTENT OF UNOFFICIAL SAMPLES

The identity of weed seeds found in seed samples serves to indicate, in some cases, the place of origin of the seed. Such information also indicates the avenue of entrance of many common and uncommon noxious weeds. The quantity of weed seeds present has a profound influence on the value of the seed as a commodity and on the value of the crop produced therefrom. To know how many and what kind of weed seeds are present is important information to the purchaser. The following statements with regard to the occurrence of weed seeds indicate the kinds most commonly found in field crop seeds, the

figures given being the percentage of samples containing the weed seed named:

Alfalfa. Green foxtail, 29%; yellow foxtail, 7%; dock species, 9%; lamb's quarters, 26%; Russian thistle, 11%; rough pigweed, 7%; night-flowering catchfly, 4%; Frenchweed, 3%; mustard species, 4%; dodder species, 3%; buckhorn, 6%; Canada thistle, 2%; Russian knapweed, 4%.

Alsike Clover. Sheep sorrel, 18%; lamb's quarters, 21%; common chickweed, 15%; mouse ear chickweed, 12%; night-flowering catchfly, 27%; yellow trefoil, 72%; cinquefoil, 9%; buckhorn, 15%; Rugel's plantain, 9%.

Crimson Clover. Meadow foxtail, 34%; green foxtail, 8%; sheep sorrel, 44%; curled dock, 12%; dock sp., 24%; common chickweed, 8%; night-flowering catchfly, 54%; buttercup sp., 30%; wild mustard, 10%; mustard sp., 40%; yellow trefoil, 52%; cutleaved cranesbill, 8%; buckhorn, 7%; blue field madder, 16%; cleavers, 6%; corn camomile, 6%.

Red Clover. Green foxtail, 35%; yellow foxtail, 10%; sheep sorrel, 23%; curled dock, 9%; dock sp., 17%; lamb's quarters, 15%; night-flowering catchfly, 17%; yellow trefoil, 12%; common mallow, 4%; wild carrot, 35%; self heal, 26%; buckhorn, 72%; common plantain, 4%; Canada thistle, 3%; chicory, 3%.

White Clover. Sheep sorrel, 77%; lamb's quarters, 33%; peppergrass, 67%; night-flowering catchfly, 22%; cinquefoil, 22%; yellow trefoil, 67%; common plantain, 67%; Rugel's plantain, 22%.

Timothy. Sheep sorrel, 26%; peppergrass, 16%; cinquefoil, 32%; evening primrose, 6%; buckhorn, 6%; blue vervain, 6%; common plantain, 6%; Rugel's plantain, 35%.

VI

CRIMSON CLOVER SEED INVESTIGATIONS

Owing to the unusual conditions with respect to supply, quality and cost of crimson clover seed in 1916 an inspection was made in the latter part of June of lots of seed offered for sale at that time. Tests were made immediately and reports sent out through the press and by notice to the county agents.

The Seed Laboratory collected and analyzed 29 samples of crimson clover seed offered for sale in the southern half of the State. These 29 samples represented 53,715 pounds of seed, sufficient to sow 2,685 acres if sown at the rate of 20 pounds per acre. The price of this seed ranged from $6.00 to $7.75 per bushel. The germination tests gave 34 per cent as the lowest and 92.5 per cent as the highest. These samples did not represent all the seed that would be offered or sold to New Jersey farmers this season, but the quantity examined seemed sufficient to indicate the general quality of the seed which would be offered. It certainly indicated that our farmers should be warned, that they might purchase with their eyes open or, in

other words, that knowledge as to germination should be in hand before selection was made for purchase, or at least before the seed was sown, so that rate of seeding might be properly adjusted.

The following gives an idea of the quantity of different grades of seed:

Germination	30–40%,	8,040 lbs.
"	40–50%,	9,240 "
"	50–60%,	13,380 "
"	60–70%,	3,960 "
"	80–90%,	6,780 "
"	90–95%,	7,635 "

It should be considered also that seed of low germination is also of low vitality, unless good seed has been mixed with dead seed and, therefore, even the increased rate of seeding may result in part or total failure, especially if environmental factors are not altogether favorable at seeding time and in early stages of development.

Table I shows in detail the results of this study.

Table I

Crimson Clover Seed Investigations

Lab. No.	County.	Stock Sampled Bushels.	Price Per Bushel.	Germ. Per Cent.
3543	Burlington,	88	$6.25	47.2
3544	"	5	.....	72.5
3548	"	44	6.00	34.0
3549	"	5	6.00	57.0
3545	Gloucester,	4	6.00	66.2
3546	"	20	6.50	46.2
3550	"	5	6.25	71.2
3547	Salem,	60	6.00	77.0
3551	"	8	6.00	56.0
3552	"	90	6.00	47.0
3554	"	16	7.00	69.5
3553	Cumberland,	60	7.00	38.5
3555	"	150	6.75	54.0
3556	"	44	7.50	44.0
3557	"	12	6.75	65.5
3558	"	60	6.75	65.0
3559	Atlantic,	10	7.40	63.5
3560	"	3	7.50	76.5
3565	"	7	6.50	65.0
3561	Ocean,	2	7.73	65.5
3562	Monmouth,	12	6.00	87.5
3563	"	1	....	63.5
3564	"	30	7.00	39.5
3567	"	100	6.50	85.0
3568	"	35	7.20	74.0
3569	"	10	6.00	73.0
3566	Cape May,	1½	6.50	85.0
3570	Mercer,	12	6.50	83.5
3571	"	¾	....	92.5

VII

PLANTS IDENTIFIED

During the year the Seed Laboratory has been the source of information as to the identity of 35 plants submitted, in most cases such plants occurring as weeds. Following is a list of plants identified and source of each specimen.

Common Name.	*Scientific Name.*	*Source.*
Crab grass,	Digitaria sanguinalis,	Trenton.
Old witch grass,	Panicum capillare,	Trenton.
Barnyard grass,	Echinochloa crusgalli,	Trenton.
Green foxtail grass,	Setaria viridis,	Trenton.
Redtop grass,	Agrostis alba,	Trenton.
Crowfoot grass,	Dactyloctenium ægyptium,	Trenton.
Low spear grass,	Poa annua,	Trenton.
Quack grass,	Agropyron repens,	Heislerville.
Slender rush,	Juncus tenuis,	Trenton.
Day-flower,	Commelina sp.,	Trenton.
Climbing false buckwheat,	Polygonum scandens,	Hackensack.
Japanese knotweed,	Polygonum cuspidatum,	Hackensack.
Knawel,	Scleranthus annuus,	Millville.
Knawel,	Scleranthus annuus,	Mt. Holly.
Knawel,	Scleranthus annuus,	Asbury Park.
Spurry,	Spergula sp.,	Bound Brook.
Thyme leaved sandwort,	Arenaria serpyllifolia,	Dayton.
Common chickweed,	Stellaria media,	Newton.
Nightflowering catchfly,	Silene noctiflora,	Mt. Holly.
Field cress,	Lepidium campestre,	Newton.
Hedge mustard,	Sisymbrium officinale,	Woodstown.
Tumble mustard,	Sisymbrium altissimum,	New Brunswick.
White clover,	Trifolium repens,	Trenton.
Alsike clover,	Trifolium hybridum,	Trenton.
White sweet clover,	Melilotus alba,	Hackensack.
Yellow sweet clover,	Melilotus officinalis,	Port Murray.
Vetch sp.,	Vicia hirsuta,	Atco.
Vetch sp.,	Vicia tetrasperma,	
Bindweed,	Convolvulus arvensis,	New Brunswick.
Bindweed,	Convolvulus arvensis,	Newton.
Ground Ivy.	Nepeta hederacea,	Bridgeton.
Horse nettle,	Solanum carolinense,	Newton.
Cleavers,	Galium mollugo,	Newton.
Hawks beard,	Crepis sp.,	New Brunswick.
Hawkweed,	Hieracium floribundum,	Somerville.

VIII

THE NEW SEED LAW

Mention should be made in this report of the fact that the present seed law is superseded by a new law enacted in February, 1916, and effective November 1, 1916. The text of this law and full explanationn is given in Circular 59 of the Experiment Station. While free analysis and report for residents is retained in the new law, it is radically different from the old, in that it provides for certain label requirements on packages of seeds. To maintain accuracy of label statements extensive inspection and analysis may be essential. To carry out this work a larger appropriation than is received at present will be essential. In fact, the general usefulness of this department

might be greatly increased with additional funds. Salary increases must be allowed to a certain extent. Extra expenditures for equipment and operation must follow extension of the work. With a fixed maximum appropriation for any department it is a fallacy to expect normal development. Adequate salaries must be sacrificed for operating expense or vice versa, and limitation either way inhibits progressive development.

A bushel tax on seeds, also a registration tax on commission box seeds sold in the State, is suggested as a possible means of securing funds for the prosecution of this work. This would place the department on the basis which secures the fertilizer and feed control wherein a tonnage assessment supplies ample funds.

IX

ALFALFA EXPERIMENTS

While the work herein reported may be more strictly in the province of the agronomist, yet it may also be considered as a problem for the seed analyst inasmuch as the relative quality of seeds may be expressed in terms of variety and strain as well as in terms of purity and germination. With this attitude, the State seed analyst has made certain observations with regard to the growth of several strains of alfalfa, and deems them of sufficient interest for publication.

The rapidly developing acreage of alfalfa in this State has not been without its stories of failure to secure satisfactory results. These failures may be attributed to many causes. Where no results whatever have been secured, soil troubles are undoubtedly concerned. Acid soil, poor preparation of seedbed, too many weeds, lack of moisture and lack of inoculation, contribute to disappointment. Where a good initial stand is secured, but one which begins to deteriorate too soon, then changing soil conditions, disease, encroachment of weeds, undue climatic conditions, and unsuitable strains or varieties may be looked upon as causal agents. Extensive studies may have been made relative to soil conditions and alfalfa production. Comparatively little has been done in this section of the country in determining the relative value of the seed from different sources or of different strains. To the great majority alfalfa is simply alfalfa, or it may be Grimm alfalfa. More recently, however, we have come to recognize another strain with certain definite characters, and known as Turkestan alfalfa, taking its specific name from its place of origin. However, the total work along

this line is minus any definite conclusions and devoid of suggestions or information that will answer the several questions that may be raised by the New Jersey farmers regarding this matter of varieties and strains.

In commencing this work the idea in mind was to study the development of various strains of alfalfa under New Jersey conditions especially with reference to the persistence of the stand, or, in other words, the ability of these strains to withstand the climatic and other environmental factors. For this seed of a number of different strains was secured and planted in different parts of the State. It should be explained that the word "strain" as here used does not imply that in every case the seed used was from plants developed by selection from apparently different or superior plants. While true in a few cases, yet the majority should be described as "regional strains," in that the seed was obtained from plants growing in different states or countries. At the present time, this is, with few exceptions, the only basis for making distinction in alfalfa seed and is not altogether satisfactory, as one may readily see.

I. College Farm Experiment

1. Nine plots, of an area of .01 of an acre each, were planted in clay loam soil on the College Farm, August 29, 1913. Seed for these plots was obtained from the following sources: *Plot 1.*—New Jersey seed collected in 1913 from plants which had persisted from previous plantings on the College Farm. These plants were along fence rows and in chicken runs enclosed from an alfalfa field. It should be stated that the plants in these enclosures were particularly vigorous and seeded abundantly in the two years they were under observation. *Plots 2, 6* and *7.*—Nebraska, Kansas and Utah seed obtained from experiment stations of these states. *Plot 3.*—French seed obtained from importer, Nungesser-Dickinson Seed Company, New York. *Plots 4, 5, 8* and *9.*—Seed of strains developed and supplied by the Dakota Improved Seed Company, of Mitchell, South Dakota.

Computed on the basis of tons of air-dried alfalfa per acre, the total production of the plots for the four cuttings recorded is as follows:

Plot.	*Strain.*	*Yield.*
1	New Jersey, 1913,	5.5 tons
2	Nebraska,	5.0 "
3	French,	4.1 "
4	Disco 316,	4.2 "
5	Disco 62 B,	3.8 "
6	Kansas,	4.8 "
7	Utah,	4.5 "
9	Disco 32 C,	4.5 "

The number of trials is too limited to warrant basing hard and fast conclusions on these results. Examination of the plots indicates differences which it is impossible to express in figures. Plot 1 is noticeably superior in stand and vigor. Plots 3 and 5, on the other hand, are decidedly inferior, noticeably thinner, and weeds becoming more numerous. It is doubtful if these plants would be considered profitable after another season. The uniformity of plots 2, 6 and 7 is worthy of mention as they represent strains of seed now available in quantity.

II. Westwood Experiment

August 19, 1914, twenty strains of alfalfa seed were planted on the farm of D. Y. Lewis, at Westwood, Bergen County, New Jersey. The seed was planted on shallow clay loam soil, in rows 125 feet long and 4 feet apart, and 5 strains to each row. This land had never grown alfalfa before.

LIST OF ALFALFA STRAINS USED IN EXPERIMENT

No.	*Name of Strain.*	*Source of Seed.*
1	Disco No. 28,	Dakota Imp. Seed Co.
2	Disco No. 78,	Dakota Imp. Seed Co.
3	New Jersey, 1914,	College Farm, New Brunswick.
4	Disco No. 38,	Dakota Imp. Seed Co.
5	Disco No. 51,	Dakota Imp. Seed Co.
6	Disco No. 32c,	Dakota Imp. Seed Co.
7	Disco No. 79,	Dakota Imp. Seed Co.
8	Disco No. 52,	Dakota Imp. Seed Co.
9	Disco No. 19a,	Dakota Imp. Seed Co.
10	Commercial, Kansas seed,	Dakota Imp. Seed Co.
11	Commercial, imported Turkestan,	Dakota Imp. Seed Co.
12	Commercial, Imported Arabian,	Dakota Imp. Seed Co.
13	New Jersey, 1913,	College Farm, New Brunswick.
14	Baltic, Colorado seed,	Col. Experiment Sta.
15	Nebraska seed,	Nebraska Experiment Sta.
16	Arizona seed,	Arizona Seed Co.
17	Hansen's Semipalatinsk,	South Dakota Experiment Sta.
18	Utah seed,	Utah Experiment Sta.
19	Kansas seed,	Kansas Experiment Sta.
20	Grimm, Colorado grown,	Col. Experiment Sta.

On November 19, 1914, all strains were growing except No. 17, which *apparently failed to germinate.* Numbers 1, 12, 16 and 19 appeared to be superior in size attained at this date.

Observations in 1915 indicated certain differences in the strains which will be found stated in observations for 1916. Plants growing in rows were cut regularly with alfalfa in adjacent areas.

On June 5, 1916, the writer and Mr. L. F. Merrill, farm demonstrator for Bergen County, who has given his interest and services to this work from the beginning, made careful examination and comparison of the various strains.

Five groups were formed, Group 1 containing the superior strains and each succeeding group being considered inferior in regard to height of plant, color and condition of foliage, and persistence of stand; Group 5 representing those which had wholly disappeared.

For purposes of comparison there is included the classification of these strains as made by Mr. J. B. R. Dickey of the Extension Division. His observations were made August 31, 1916, when the third crop was about one foot high.

Writer's Classification.		*Dickey's Classification.*
Group 1—	Disco 79	Disco 32c. Disco 79. New Jersey, 1913.
Group 2—	Disco 28 Disco 78 Disco 32c New Jersey, 1913	Disco 28. Disco 78. Nebraska. Arizona.
Group 3—	Disco 51 Disco 52 Disco 19a Kansas Comm. Turkestan Nebraska Kansas Exp. Sta.	Disco 51. Disco 19a. Kansas Comm. Baltic. Kansas Experiment Station.
Group 4—	New Jersey, 1914 Disco 38 Baltic Arizona Utah	New Jersey, 1914. Disco 38. Disco 52. Turkestan. Utah.
Group 5—	Arabian Semipalatinsk Col. Grimm	Arabian. Semipalatinsk. Col. Grimm.

When observed by the writer, October 3, 1916, the various strains were maintaining their same relative grouping, although the strains in Group 4 showed even further advances in deterioration. This was true especially of Turkestan alfalfa.

III. Freehold Experiment, August, 1914

Seed of 20 strains previously listed were planted in small plots on the farm of Mr. D. D. Solomon at Freehold, New Jersey. The soil is a sandy loam. These plots were adjacent to an alfalfa

field, planted at the same time and were cut regularly with that field. On July 22, 1916, observations were made, relative to height, color and persistence of stand, the writer being assisted in this by Mr. W. B. Duryee, Jr., county demonstrator for Monmouth County. The results of this agree so closely with those made at Westwood that it does not seem necessary to include a detailed statement. It was reported by Mr. Solomon that the plants from New Jersey seed, both 1913 and 1914, make a much quicker start after cutting than any of the other strains.

IV Discussion of Results

The results obtained in growing these various strains have only a limited direct application, and, for the most part, indicate the possibilities and need of further extension of this work. It is made apparent, however, that differences do exist in strains of alfalfa, and that advantage may and should be taken of this fact in the development of superior strains for this region, and in purchase for present planting.

For the present it is in keeping with these observations and with the statements of the United States Department of Agriculture, to avoid the purchase of French, Arabian and Turkestan seed, which have proven inferior to American strains under similar conditions. The fact that one or more strains prove greatly superior in such a test means little to the farmer, unless there is available a supply of seed of those particular strains to meet the demand that might be created. Those strains having the best record in this test are those with a very limited seed supply. However, those ranking next are strains which, at the present time, are represented by considerable quantities of seed and appear in the market as Kansas seed, Nebraska seed, etc. In this connection, another problem presents itself and that is the probability of Kansas seed being Kansas seed, or Utah seed being Utah seed, even when so labeled. This is a matter which will receive due attention, as many of the seed-producing states are now taking steps toward the certification and registration of seeds, that both the seller and the buyer may have all the advantages of a superior product.

To what extent alfalfa selection and breeding work should be carried on in the East is a matter of question. The chief limitations are the uncertainty of getting a seed crop, and the cost of producing such seed in relation to extra returns from superior strains. It does not seem fair to relegate this to the realm of the impossible until the problem has received a proper amount of attention.

REPORT OF THE DIVISION OF EXTENSION IN AGRICULTURE AND HOME ECONOMICS

Division of Extension in Agriculture and Home Economies

ALVA AGEE, M.S., Director.
*JOHN H. HANKINSON, A.B., State Leader of Farm Demonstration.
†JOHN B. R. DICKEY, B.S., Extension Specialist in Soil Fertility and Agronomy.
‡ALLEN G. WALLER, B.S., Assistant Extension Specialist in Agronomy.
§LAWRENCE G. GILLMAN, B.S., Extension Specialist in Fruit Growing.
‡HARRY C. HAINES, Assistant Extension Specialist in Fruit Growing.
VICTOR G. AUBRY, B.S., Extension Specialist in Poultry Husbandry.
MISS M. ANN HAUSER, B. S., Extension Specialist in Home Economics.
‡WM. H. MCCALLUM, B.S., State Leader in Boys' Club Work.
**MISS FANNIE F. COOPER, B.S., State Leader of Girls' Club Work.
††MISS EMILY P. LEEDS, Assistant Girls' Club Leader.
ROSCOE W. DE BAUN, B.S., Extension Specialist in Market Gardening.
‡‡JOHN W. BARTLETT, B.S., Extension Specialist in Dairy Husbandry.
CARL R. WOODWARD, B.S., Editor.
PAUL B. BENNETCH, M.S., Superintendent of Farm Demonstration for Sussex.
†WM H. HAMILTON, B.S., Assistant Superintendent of Farm Demonstration for Mercer.
W. B. DURYEE, JR., B.S., Superintendent of Farm Demonstration for Monmouth.
L. F. MERRILL, B.S., Superintendent of Farm Demonstration for Bergen.
ELLWOOD DOUGLASS, Superintendent of Farm Demonstration for Atlantic.
GEORGE B. THRASHER, Superintendent of Farm Demonstration for Cape May.
IRVING L. OWEN, B.S., Superintendent of Farm Demonstration for Middlesex.
GEORGE T. REID, Superintendent of Farm Demonstration for Burlington.
WARREN W. OLEY, B.S., Superintendent of Farm Demonstration for Cumberland.
‡A. M. GOODMAN, B.S., Superintendent of Farm Demonstration for Morris.
§§ELWOOD L. CHASE, B.S., Superintendent of Farm Demonstration for Passaic.

* Appointed July 1, 1916, to succeed A. L. Clark, resigned.
† Appointed March 15, 1916.
‡ Appointed March 1, 1916.
§ Appointed February 1, 1916.
** Promoted from Assistant in Home Economics to State Leader of Girl's Club Work, July 1, 1916.
†† Appointed March 13, 1916; resigned November 18, 1916.
‡‡ Appointed May 1, 1916.
§§ Appointed May 11, 1916.

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Division of Extension in Agriculture and Home Economics

REPORT OF THE DIRECTOR

ALVA AGEE

The director of the division of extension and home economics makes report of the work of the division largely through the reports of specialists, which he presents for your consideration. The basis of organization has been given in previous reports, and the money available for use in extension work is expended upon definite projects. Administration has been easy because the staff of workers have the spirit of service to the people.

A change of some importance in the relations of the division of extension to the State Department of Agriculture is adding to the effectiveness of the work. The State Board of Agriculture in the new Department of Agriculture, which was created July 1, 1916, made request of the State Agricultural College that the present director of extension should become the secretary for agriculture in the State Department and, through service in this dual capacity, the desire was expressed that he should coördinate the work of the two institutions so that all overlapping should be eliminated. One possibility in such coördination that is being realized affects a leading project in our extension service; namely, county farm demonstration work. County boards of agriculture, which are a legal body in direct touch with the State Department of Agriculture, are accepting a plan of reorganization that provides for community representation, and this county body becomes the directing force within the county of the farm demonstration office. While maintaining its legal character as a county board of agriculture, the representatives of communities which form its council are the advisory committee in farm demonstration work, and the farm demonstration office becomes its headquarters. Such an arrangement strengthens the county boards, which have a record of good service in our State, and, at the same time, they insure a broadly democratic control of the farm demonstration work.

Another gain in such coördination is found in the case of farmers' institutes. The money for this educational service to the State is appropriated to the Department of Agriculture, and it can rightly place the direction of such meetings in the hands of the county board of agriculture which, as an advisory committee of demonstration work, will want to make the meetings a part of the educational work of the demonstration office.

County demonstration work always will be a leading project and the report of the State leader will indicate its practical and helpful character. When the State Department of Agriculture was organized July 1, 1916, Mr. A. L. Clark, who had been in charge of county demonstration, accepted the position of chief of the bureau of land, crops and markets in the department, and John H. Hankinson, who was the superintendent of farm demonstration for Mercer County, was appointed State leader. The reports of the county demonstrators are a source of some information respecting the splendid work that is being done. The reports of the specialists in agronomy, fruit-growing, market gardening, poultry husbandry and home economics are evidence of the increasing value of the work and its acceptability to the public.

The organization of boys' club work as a project has been delayed in our State on account of the excellent work along this line in charge of county Y. M. C. A. secretaries, county superintendents of schools and others, but such work was made a project March 15, with Mr. W. H. McCallum in charge. New Jersey has hundreds of thousands of acres of land lying in an unproductive condition that can be brought into profitable production when need arises. It is the duty of the State Agricultural College to determine the areas capable of improvement and to demonstrate the best means of bringing these light soils into production when need may arise in the future. The soil fertility project was approved. A dairy husbandry project was undertaken during the year.

The extension division continues to be directly concerned with all rural life interests. An increasing list of country ministers, teachers and groups of farmers express appreciation of the service of specialists and county farm demonstrators in assistance to them in their efforts to improve rural life conditions.

Problems in distribution of farm products have equal value with those in production. The marketing project that was outlined in the extension division does not continue in charge of a specialist, such work being a leading feature in the State De-

partment of Agriculture, with which our extension work is coördinated. Notwithstanding this fact, the college and experiment station have made good progress in some demonstrational work. Two successful coöperative enterprises have been organized as a direct result of activities in county farm demonstration, and all of our demonstrators and several of the specialists are assisting producers to put their products into the best form for market.

An unfortunate interpretation of the State act making appropriation prevented the use of any State money for extension publication during the past year. The following is a list of the publications made through other funds:

Bulletins

No. 8, February, 1916.	40 p.	Director's Annual Report.
No. 9, June, 1916.	4 p.	Announcement of Educational Milk-scoring Demonstrations.

New Letters

Vol. 3, No. 1 to Vol. 3, No. 52.

REPORT OF THE STATE LEADER IN FARM DEMONSTRATION TO JULY 1, 1916

A. L. Clark

Two new counties were organized in the spring of 1916. Leading farmers, members of the grange and the county boards of agriculture requested our coöperation in Morris and Passaic Counties. Accordingly, the coöperative plan for carrying on farm demonstration work was presented to the county boards of freeholders in these counties and accepted. Mr. A. M. Goodman was appointed for Morris County and Mr. Ellwood L. Chase for Passaic County. With these additions New Jersey now has eleven counties coöperating in the support of farm demonstration work.

The state leader has met with all the advisory committees during the past year. This plan was adopted in 1915 and all the county men have shown their willingness to comply, and each worker now knows definitely just about what his work will be for every week during the year.

Emphasis has been placed upon the need for more publicity work at our conferences. Every demonstrator who has become established in his county is now sending out a monthly report of activities in the form of a letter to members of his advisory committee, and other interested persons. Some of these mailing lists embrace several hundred names. The newspapers have always supported the work and at least one newspaper item is published each week in every county. Signs have been used much this year on demonstration plots. These signs are large and the letters permit easy reading as one

rides by in an automobile. Undoubtedly more of them will be used in the future.

The county boards of agriculture have been strengthened especially by the county demonstrators. Farmers' institutes were never better supported than last winter. The three largest institutes were held in counties where the county demonstrators could assist in arranging the programs and arousing interest. The total attendance of these three meetings was over two thousand.

The grange in many places is beginning to feel the effect of the work of these hustling agents. In Atlantic County a new subordinate grange and a pomona grange were organized largely as a result of the efforts of the demonstrator.

REPORT OF THE STATE LEADER IN FARM DEMONSTRATION SINCE JULY 1, 1916

JOHN H. HANKINSON

The growth of farm demonstration work in New Jersey has been rapid. On July 1 eleven counties had county superintendents. In every county progress was evident. That the greatest result of farm demonstration work may be achieved, however, stronger county organization should be developed and more definite plans and methods followed by the workers. Upon taking up the work on July 1, the project plan was adopted for the work of the state leader as well as for the work of the county men, and this support is made by projects. Working conditions in the office and throughout the state have been made very favorable for the state leader by the director of extension. The county superintendents also have coöperated heartily in the projects in which they were concerned. In fact, without such coöperation the results reported would not have been possible.

Project: To Make Farm Demonstration Work More Effective Through Improvement and Standardization of Projects

In order to carry out the purpose of this project a change was made in the records sent in by the county superintendents to the state leader. A monthly report on each project was substituted for the remarks sent in on the back of the weekly report blanks. This change was made to facilitate the grouping of information by projects and to enable the filing of available data where it could most easily be used. This necessitated a change in the office filing methods, which has been accomplished.

Along with the change in records, emphasis was placed on the necessity of securing results from demonstrations. The county superintendents were urged to give more consideration to securing these results in definite shape.

In order that the records thus secured should have the greatest result on the improvement and standardization of projects, twelve committees were appointed, composed for the most part of two county demonstrators and an extension specialist, to consider the projects taken up along each line during the past season, and make recommendations for the future. These com-

mittees are scheduled to report at our November conference of extension workers. The reports will receive general discussion at the conference and will be taken home by each county superintendent for further conference with advisory boards and local committeemen. It is planned to hold a series of three conferences in January; one for the southern, one for the central, and one for the northern group of counties, in which final action may be taken on project plans for the coming year.

Project: Farm Demonstration Exchange

The Farm Demonstration Exchange which was inaugurated last year is now being sent out to a mailing list of about 350 representative men in New Jersey. Its purpose is to present a monthly report of the extension work carried on in New Jersey, and especially in counties organized for farm demonstration. Beginning with the October issue a rearrangement of material by subjects, putting emphasis on results achieved, has been attempted. This change was made with the hope that it would make the material more readable and more valuable.

Project: Correlation of Work of County Superintendents with that of Extension Specialists

Under the present New Jersey plan, in which the director of extension controls both the extension specialists and the county superintendents, the correlation of work is made very easy. Beginning with October the extension specialists will make monthly reports on their projects for the project files in the same way as the county demonstrators. This will bring in one place a complete record of all extension activities carried on in the state along each line.

Project: Fair Exhibits

Former state leader, Alexis L. Clark, inaugurated during the spring a new plan of fair exhibits by which the extension division instead of exhibiting directly at local fairs through the State, prepared an exhibit which went to each one of the eleven county demonstrators for the purpose of supplementing local material. The present state leader carried out this plan and the following exhibits were sent out to the county men:

Twenty-seven charts on agricultural subjects.

Four large mounted pictures showing the agricultural college, grounds and adjacent buildings.

Two cloth placards describing extension work.

Various samples of good equipment for spraying, nailing presses, etc.

Entomological exhibits and canned goods.

Models of poultry houses and colony houses.

The only place in which the college and experiment station, either through the extension division or other departments, made separate exhibits, was at the Monmouth County Fair, and at the Inter-State Fair, Trenton.

Project: Mercer County Farm Demonstration Work

Owing to the suddenness with which the state leader had to leave his work in Mercer County, it was agreed that for a few months at least some extra time would be given to this county. One of the local projects which demanded careful attention was the development of the Farmer's Coöperative Association of Mercer County. The state leader has been present at all the executive committee meetings held by this association during these four months, both to give such assistance as he was able, and to study how such a coöperative association could best meet the present-day coöperative problems in New Jersey. He has held frequent conferences with County Agent Hamilton on club work, corn variety tests, milk producers' organizations and home economics work.

Project: The Organization of Counties to Receive a County Superintendent of Farm Demonstration

Requests from Hunterdon County for information regarding farm demonstration work were received in July, and the state leader spent several days writing to farmers, speaking at farmers' meetings and attending a hearing before the county board of freeholders. No definite action has yet been taken. The state leader also attended a meeting of the Ocean County Board of Agriculture and spoke on farm demonstration.

Project: State Meeting of Agricultural Boys' and Girls' Clubs at New Brunswick

In company with the state leader in boys' club work, W. H. McCallum, a state meeting of representatives of boys' and girls' clubs is being arranged for the Christmas vacation. This meeting is a continuation of that which the state Y. M. C. A. has attended and conducted for several years. This year the meeting will be largely composed of their boys and in their interest. The program will be largely made up of demonstrations of the work in the different departments of college and in live stock judging.

Project: Farmers' Institutes

The farmers' institutes in New Jersey are in charge of the State Department of Agriculture, and directed by Alexis L. Clark. In organized counties, however, they are being arranged for and held in close coöperation with the county demonstrators, so that institute work forms a definite project of farm demonstration work.

Project: Conference of Extension Workers in Agriculture and Home Economics

Conferences of extension workers in agriculture and home economics seem to have proved their value in developing the work. It is intended to hold four sessions a year. A very interesting conference took place August 8-9. All county superintendents of farm demonstration were present with the exception of one, and all extension specialists were able to be present.

Project: Home Economics

The development of the home economics demonstration work in the organized counties by Miss M. Anna Hauser, extensive specialist in home economics, and Miss Fannie F. Cooper, state leader in girls' club work, has been carried on in close coöperation with the county agents. The state leader has been especially interested in the agitation for a woman county demonstrator, which has been taking form in Mercer and Monmouth Counties, and which is reported under the county reports.

Project: County Organization

Farm demonstration work in New Jersey depends largely for its success upon the local leadership of the farmers in the organized counties. Such leadership finds expression in the county advisory boards and in the executive committees of the farm bureau associations. What has been accomplished, however, is but a step when compared to what will be accomplished when the farmers of the state as a whole realize their responsibility and ownership.

Organization is the keynote of modern progress along all lines. Our farmers' organizations must be coördinated and perfected for the purpose of building up our agricultural communities. A suggestive plan for the working of such coördination and development has been reported to the director of extension and to the State Department of Agriculture by a committee appointed at the August extension conference composed of the state leader and County Superintendents Duryee and Bennetch. This report suggests the coördination of the local county boards of agriculture and the advisory committees of farm demonstration, and the reorganization of the county boards on a community basis. The plan has already been approved by several counties and its adaptation and development in coöperation with those desiring such a change will be one of the main projects of the extension office during the coming year.

Atlantic County, Ellwood Douglass, County Superintendent

Orchard demonstrations were carried on with twelve demonstrators. In half of the orchards the fruit growers have asked for an increase in the size of the demonstration plot for the coming year. The method of using a portion of the orchard for the demonstration and leaving a check has been followed. Letters have been received from nearly all of the demonstrators attesting the value of the work. An example of such letters is the following from a good Italian farmer:

"The demonstrations you have carried on in my orchard have been a great benefit to me and all the other peach growers in this neighborhood. The four-year-old trees are larger than other trees I have on the place where the cost of fertilizing was twice as much."

Alfalfa demonstrations were carried out on 17 farms. During October most of the alfalfa plots have improved sufficiently to make up for the unfavorable weather conditions in August and September and promise well for success.

Several demonstrations for the control of hog cholera during the late summer were conducted and a quantity of serum was ordered from the New Jersey Live Stock Commission as an aid in preventive measures.

Sweet potato disease control demonstrations were held on 6 farms; the results were not as striking as last year, but the work will be continued by all the coöperators.

Poultry demonstrations have been located on 17 farms. Five demonstrations are being carried out on a project on the best methods for winter egg production and keeping financial and egg records.

In coöperation with Dr. T. J. Headlee, state entomologist, three very complete demonstrations were held on dusting strawberries with arsenate of lead. The results of these demonstrations are very striking and conclusive.

The Grangers' and Poultrymen's Picnic at Leiling's Park, Mays Landing, August 31, was a real success. The program consisted of tractor and caponizing demonstrations followed hy talks by prominent speakers.

Grange work in Atlantic County has been definitely assisted during the past year by the farm demonstration office. A pomona grange has been organized and a local grange. On the other hand, Mr. Douglass has received fine support from the grange and the spirit of local responsibility is fast developing as evidenced in the grand picnic, and in the meetings planned for this winter in which local people have largely made the arrangements, selected the speakers, etc.

In addition to these major lines of work, or projects, tests have been carried on of alfalfa varieties and of dusting sweet corn to prevent the ravages of corn worms. Tests to demonstrate the value of common salt as fertilizer were held and also a community corn variety test, samples of seed corn being taken from 21 different farmers. Several Sudan grass tests also were made.

Mr. Douglass reports 611 farms visited, 732 demonstrations visited, 488 office calls, 75 meetings held (attendance 1,864), 1,922 letters written, 1,967 bulletins distributed, 67 articles published, 4,933 circular letters sent.

Bergen County, L. F. Merrill, County Superintendent

Eight orchard management demonstrations were held and completed. The method used was the comparative one, part of the orchard being selected for the test and a check left. The fruit from the sprayed trees was carefully sorted into three grades; the first grade having no blemishes, the second grade being somewhat blemished, but marketable, and the third grade being unmarketable. The final results have not been fully tabulated, but partial returns indicate an increase of 70 per cent of first grade fruit in the sprayed plots. The finish of the fruit was markedly superior in the sprayed plots.

Alfalfa demonstrations are being conducted on several farms with good results. Four demonstrators undertook to grow a variety of cover crops and in spite of the severe dry weather the vetch and vetch-rye, crimson clover and mammoth red clover have made splendid growth. Alfalfa and alsike have done fairly well. Cowpeas and soybeans grew moderately well

until killed by the frost. A mixture of rye, vetch and mammoth clover has made splendid growth. Alfalfa and alsike have done fairly well. Cowpeas and soybeans grew moderately well until killed by the frost. A mixture of rye, vetch and mammoth clover has made remarkable growth on one of the plots.

A cow testing association was organized in Bergen and Passaic Counties; 114 cows were signed from Passaic and about 440 from Bergen.

Celery disease control and spraying work for the control of blight carried on under the direction of the county superintendent, assisted by Mr. W. S. Kraut, of the experiment station, is giving splendid results, although no figures are yet available. The necessity of thorough and frequent spraying was emphasized.

Poultry demonstrations have been started with men keeping poultry records. Three men are planning trap-nesting demonstrations.

The first lot of peaches packed in Georgia carriers under Demonstrator Merrill's peach marketing project brought a good advance in the New York market over the fruit marketed in the usual way in Paterson.

Demonstration work has also been conducted in Bergen County on the use of salt as fertilizer, top-dressing grass sods, and in organizing girls in agricultural clubs.

Mr. Merrill reports 810 farms visited, 302 demonstrations visited, 401 office calls, 95 meetings held (attendance 3,103), 1,743 letters written, 2,470 circular letters sent out, 20 articles published and 812 bulletins distributed.

Burlington County, George T. Reid, County Superintendent

Sixteen farmers raised American Giant potatoes grown from selected seed under Mr. Reid's direction, securing very favorable results. This variety of potatoes, which forms a large part of the shipments from Monmouth County, is seldom grown in Burlington County. Mr. Reid's demonstrations were planned to show that Giants can be grown successfully in this county.

Nine demonstrations testing the value of the home production of seed potatoes are being carried out. Results will be announced next season, but those who planted home-grown late crop seed this spring secured good results. First crop seed greened and replanted does not seem to germinate sufficiently well to make the practice worth while.

Ten farmers conducted alfalfa demonstrations and most of the fields have a good stand. One farmer in Burlington County had 90 acres seeded in August, 1916, growing in good shape.

A cow testing association among 9 farmers, with 410 cows under test, was organized in February, and is doing good work. Twelve farmers are taking part in a dairy feeding demonstration, and balancing of rations is the general basis of these demonstrations.

Demonstration work has been done in the testing of salt as fertilizer, forage crops for swine, trying out local varieties of corn to demonstrate which is the most profitable to grow, the comparison of dusting and liquid spray machinery in the orchard, and in better methods of growing truck crops.

Mr. Reid reports 968 farms visited, 417 demonstrations visited, 620 office calls, 786 telephone calls, 78 meetings (attendance 5,852), 1,643 letters written, 6,116 circular letters sent out, 156 bulletins distributed and 50 articles published in the press.

Cape May County, George B. Thrasher, County Superintendent

Demonstrations to show the value of spraying tomatoes against blight were continued and enlarged this season. Two canneries bought and operated traction sprayers on 80 acres (16 farms) under Mr. Thrasher's direction. Although the blight was not severe this season such a difference existed in the quality of the tomatoes from the sprayed areas that the canneries and the farmers were very much pleased. The companies furnished the sprayer and an operator, and advanced the material; the farmers provided a team and driver.

Three farmers have undertaken to plant orchards in accordance with the recommendations of the experiment station through Mr. Thrasher. One of these orchards was planted in the spring of 1915; this orchard had made a fine growth this season and developed a good supply of fruit buds so that some fruit should be expected next year. It has been cared for properly in every way. The two other orchards were planted this spring. Five demonstrations have been conducted on other orchards this season according to the suggestions of the county superintendent; the results have been uniformly good. *Unfortunately, it has been impossible to include the actual records* in this report, except in one case which showed a profit of $341.80 on an orchard of 22 trees consisting of Carmen, Elberta and Iron Mountain varieties. The total receipts for the orchard were $392.80 and the total expenses $51.00. These expenses do not include overhead charges such as rent of land, interest, etc.

Ten demonstrations are showing the value of soybeans and cowpeas to enrich the soil. Late potatoes have been planted in some cases, winter grain in some cases. It is evident, even at this time, that the crops are being greatly benefited by the soybeans and cowpeas. In every case Mammoth Yellow soybeans made a far superior growth to Whip-poor-will cowpeas.

Three separate projects have been carried on in poultry work. One demonstration has been conducted on the breeding and rearing of pullets for winter egg production. Four demonstrations were conducted on the feeding of 10 per cent of milk powder with the dry mash in starting chicks off. The results were uniformly successful. Four demonstrations were conducted on farm poultry flock management. The plan of this demonstration is to keep records of receipts and expenditures, to demonstrate the economic value of the practice suggested by the experiment station.

The county superintendent has also conducted demonstrations to show the value of selecting sweet potato seed free from stem rot, to test out the value of salt as fertilizer, and to introduce alfalfa more widely in the county.

Mr. Thrasher reports 966 farms visited, 295 demonstrations visited, 75 persons calling at the office, 106 telephone calls, 60 meetings held (attendance 2,583), 1,403 letters written, 990 circular letters, 136 bulletins distributed and 37 articles published.

Cumberland County, W. W. Oley, County Superintendent

Cumberland County adopted the policy of farm demonstration in November, 1915. Five demonstrations were carried on in orchard management with very favorable results. Detailed reports have been received from two of these orchards. The results of intercropping in a 3-year-old peach orchard showed that at this age, provided the trees were planted far enough apart, no damage is done by careful intercropping and that the crop between the trees may more than pay for all expenses of the orchard, leaving the fruit sold as clear profit. This orchard covered 1½ acres, and consisted of 104 peach trees with 34 apple trees interplanted. The cost of caring for the orchard, including manuring, spraying, pruning, thinning the fruit, cultivation and one-half interest at 6 per cent on land valuation, was $40.25. The cost of the intercrop of peppers, including fertilizer, cost of plants, preparation of land, planting, cultivating, picking and one-half interest at 6 per cent on land valuation was $49.25. The land returned a clear profit above all expenses of $79.91 and the trees are just coming into their best production another year.

Two demonstrations were conducted to show the value of using selected sweet potatoes for seed that are free from stem rot. The potatoes have been dug and where selected seed was used there is a remarkable freedom from stem rot. Seed has been selected for next year according to directions, and 4 special hampers have been obtained for demonstration purposes.

Eight farmers are growing legumes for hay, soil improvement and sod. A heavy crop of vetch turned under for potatoes increased the yield approximately fifty baskets to the acre. As a result 6 acres of white sweet clover will be planted on one farm next season. Soil improvement plots of rye and vetch are doing nicely. Oats and peas yielded, in July, 3 tons to the acre of good hay on one place. On another some trouble was experienced owing to poor soil.

Seven demonstrations are being run on winter egg production. The pullets have been placed in houses and are being fed and cared for according to the experiment station instructions. Records are being kept on blanks furnished by the experiment station and a profit and loss sheet covering both profit over feeding and profit over labor cost is kept. Two pedigreed poultry demonstrations have been started. Trap nests are installed and records are being kept.

Minor demonstrations have been carried on with the spraying of tomatoes to control leaf blight, salt tests to find out whether this material can supplant potash in the soil, a corn breeding and variety test, farm meadow drainage work and work on the eradication of the strawberry weevil.

Mr. Oley reports 979 farms visited, 221 demonstration visited, 442 callers at the office, 874 telephone calls, 83 meetings held (attendance 4,264), 1,529 letters written, 1,318 circular letters sent out, 614 bulletins distributed and 31 articles published.

Mercer County, William H. Hamilton, Assistant County Superintendent

In January, John H. Hankinson, then county superintendent, resigned. The resignation was not accepted, and on March first he went on a half-

time basis, with William H. Hamilton, of Somerset County, as assistant. On July 1, Mr. Hankinson was transferred to the position of state leader, Mr. Hamilton acting as county superintendent. On November 1, at the request of the executive committee of the farm bureau, Mr. Hamilton was appointed county superintendent of farm demonstration.

During the season nine farmers tested the value of harrowing their alfalfa fields; the tests have not proceeded far enough to show results conclusively.

Two demonstrators have planted about fifteen varieties of alfalfa under the same field conditions, under the direction of extension specialist in soil fertility, J. B. R. Dickey. The seeding of alfalfa in Mercer County is growing steadily, due in a large measure to the demonstartions carried on during the past three years. The bureau did not carry on any formal alfalfa demonstrations this year, confining itself to publicity of well tried methods and of fine fields already growing in the different communities.

Corn demonstrations in Mercer County included the "ear to the row" corn variety test and breeding demonstration. Tests to show which was the most productive of six varieties of corn were carried out on six farms. This test has been running for three years. The results show that corn which is adapted to the locality gives a much better yield than corn which is not. Although corn matures to a certain extent, if it does not ripen throughly it seems to lack vitality. One of the local strains with a medium type grain and slightly tapering ear has been giving the highest yields.

Four demonstrations were carried on in the county on hog management. The work emphasized the feeding of forage crops, the use of self-feeders, and the balancing of the corn ration with high protein feed, such as digester tankage. Careful records were kept of receipts and expenditures on all farms and the results are being tabulated. On every farm a good profit was shown.

Orchard demonstrations formed an important part of the work. The plan of these demonstrations was similar to that of the hog demonstrations noted above. Demonstrators agreed to follow the suggestions of the experiment station, through the county superintendent, in the care of the entire crop throughout the entire year and keep accurate financial records. In one five-acre orchard the average yield was less than 700 bushels. In 1915, the first year that up-to-date-methods were used, the yield was 1,967 bushels of apples.

In 1916 the crop was about 5,500 bushels, for which the owner received a little over $5,000. The total expense, including labor cost, was between $1,500 and $1,600. In two months over 400 people visited this demonstration, not including 500 who came in an automobile tour during the summer.

Demonstrations in the securing of home-grown seed potatoes gave important results in Mercer County this year. In the spring, 5 growers planted seed from home-grown stock and received fine results, even better than from the best certified Maine-grown seed. Fifteen coöperators planted seed this summer for second or late crop potatoes to be used next season. Three coöperators dug the first crop potatoes while they were green, and placed them in cold storage to be planted next season against home-grown second crop. This demonstration is in its third season, and the results

seem to point conclusively that the finest kind of seed potatoes can be raised in Mercer County, provided the seed is planted in July or early August. It still remains to be shown whether the first crop, if properly cared for and dug green, would give equal results.

On coming into the county March 1, Mr. Hamilton was given charge of the club work in the county and made county club leader. This work has taken a great deal of his time and attention during the season. Four sets of clubs have been organized: corn clubs, garden clubs, poultry clubs, and girls' canning clubs. Miss Fannie F. Cooper, state leader in girls' club work, had direct charge of the work with the girls' canning clubs. The club contests which followed were carried through successfully, a large number completing their work. Owing to the infantile paralysis epidemic the agricultural Field Day, for which great preparations were made, had to be abandoned. A county exhibit meeting, however, will be held in November at Lawrenceville, at which the results of the work will be given, and prizes awarded.

The Farmers' Coöperative Association of Mercer County, which was organized last fall, has been conducted successfully during its first year; there are now over 200 members, although no effort has been made to build up the membership. This association so far has engaged only in buying supplies, and up to October, 1916, orders had been filled for over $100,000 of seeds, fertilizer, etc. The officers and members are pleased with the results and are convinced that many dollars have been saved to each member. The standard of quality of the goods purchased has been high.

Two home economics weeks, so called, were held in the county during the summer under the direction of the farm bureau. Demonstrations were given by Miss M. Anna Hauser, extension specialist in home economics, and a feature of the work was the forming of community committees of women. These committees took charge of the meetings, and aroused home economics interest in the community; as a result the attendance at the second week's meeting was double that of the first, the average being 50 persons. In one little country school 84 women were present to witness a canning demonstration. The question of having a woman county demonstrator for another season is being discussed.

Miscellaneous demonstrations have been conducted in the county as follows: cover crops 5, dairy 2, feldspar tests 4, salt tests 7, lime on vegetables 1, celery spraying demonstrations 1, cantaloupe demonstrations 3.

Mr. Hamilton reports the following activities: farms visited 897, demonstrations visited 488, calls at office 612, telephone calls 488, letters written 1,441, circular letters sent out 4,760.

Middlesex County, Irving L. Owen, County Superintendent

Poultry demonstrations have been run in Middlesex County during the past year; 4 of the demonstrators will complete a year's work during November and results will be summed up. During October considerable time has been put upon the securing of new coöperators for next season, so that there would be at least ten in the county. In two cases the county demonstrator has assisted in the remodeling of old buildings.

Five demonstration orchards were conducted. One coöperator reports 100 per cent improvement in the crop due to suggested methods. The three apple orchards all showed improvement and better fruit than has been obtained for many years. In the peach orchard demonstrations the crop was very light and the demonstrations show no marked improvement in results. Pruning demonstrations for next year's work will be started in the late fall.

Twenty demonstrations have been conducted on the growing of legumes throughout the county.

Eleven men have seeded down fields of alfalfa in accordance with the suggestions of the county superintendent. Other crops used have been soybeans and cowpeas for green manure and hay, winter vetch and sweet clover.

Miscellaneous demonstrations carried on in the county consist of dairy record keeping 3, soil fertility 8, and market gardening 3.

Mr. Owen reports 662 farms visited, 160 demonstrations visited, 260 office calls, 467 telephone calls, 44 meetings (attendance 1,262), 820 letters written, 970 circular letters sent out, 30 articles published in local press, 175 bulletins distributed.

Monmouth County, W. B. Duryee, Jr., County Superitnendent

The Monmouth County Shippers' Association which was formed last spring by a committee of the farm demonstration office, with Mr. E. A. Sexsmith as chairman, has had a successful initial season. At a recent meeting of the members it was announced that 20 fruit and vegetable growers sold about $60,000 worth of produce. The farmers in the vicinity say that it has brought thousands of dollars to them by making dealers pay the full market price. The association members also save a great deal by buying their supplies coöperatively. We believe this is the first organization in the United States to handle such a variety of produce successfully in nearby markets.

Probably the most successful line of work conducted in the county during the past year has been with potatoes. Two demonstrations were conducted to show the varying productivity of individual potatoes by tuber unit tests, which attracted wide attention. In connection with this a test was made to show the effect of planting seed pieces from the seed end, stem end and the middle of the tuber. Both tests did much to emphasize the value of good seed. Thirteen demonstrations were conducted to show the possibility of producing seed potatoes in Monmouth County by planting the crop late. To secure profitable yield in the hot, dry autumn months is apparently the only limiting factor. There seems to be no question now as to the value of the seed once it is secured. One demonstration or experiment was conducted in coöperation with the plant pathology department of the experiment station to determine the value of spraying against blight. This is the third year such an experiment has been conducted in the county and results seem to be still inconclusive.

Extensive tests were made to determine the value of salt as a substitute for potash on potatoes. The result of these tests were negative, the salt

appearing to injure the stand of potatoes in such a way as to diminish the yield where used.

Miscellaneous demonstrations were conducted with orchards, raising hogs on pasture, the value of tomato spraying, the value of spraying cucumbers for pickles, the value of soybeans with corn for silage, neighborhood corn variety tests, tests to demonstrate the value of Sudan grass as a forage crop, tests to demonstrate the value of sweet clover as a forage crop, demonstrations in poultry management, tests to demonstrate alfalfa troubles, tests on the eradication of the onion maggot and control of the strawberry weevil.

Six home economics clubs for girls have been organized in this county, and applications have been received for organizing three more. In spite of the epidemic of infantile paralysis these clubs have had a very successful season under the direction of Miss F. Cooper, state leader in girls' club work, and Mrs. Magee. In order to meet the demand for more clubs a county leader on full time must be obtained. A committee to secure funds for this purpose and to take care of the work has been chosen. The school boards, county board of agriculture, and the office of farm demonstration are represented on this committee. An exhibit of 534 cans of fruits and jellies was sent from these clubs to the County Fair, and these attracted wide attention.

Mr. Duryee reports the following activities: Farms visited 791, demonstrations visited 219, days spent with extension specialists 35, calls by farmers at county superintendent's office 735, telephone calls 1,104, meetings held 91 (attendance 5,051), press notices sent out 127, letters written 2,731, bulletins and circulars distributed 466, monthly letters 6,773, granges visited 15.

Morris County, A. M. Goodman, County Superintendent

Farm demonstration work in Morris County began March 1, with the employment of A. M. Goodman as county superintendent of farm demonstration. Work during the first summer has been conducted along the lines of corn variety tests, alfalfa demonstrations and poultry demonstrations. Twenty coöperators were secured for the alfalfa plot demonstrations. In spite of several failures, the plats are for the most part doing well.

Two alfalfa field demonstrations were started in accordance with instructions of the farm demonstrator which are doing well. One of the greatest problems seems to be to keep the chickens and other farm animals from destroying the seedings while they are young.

A pig club was organized in coöperation with the County Y. M. C. A. and school superintendent, 9 boys taking part. On the 28th of October the boys held their show, at which time the pigs were judged and prizes awarded. Three of the hogs weighed over 200 pounds, the heaviest 282 pounds. A team made up of three boys from the club won first place in the pig judging at the boys' and girls' exhibit at Springfield, Mass., one of the team winning the sweepstake prize. At the home show one of the neighbors offeted the use of his pure-bred boar for the three sows that the pig club boys owned. The father of one of the boys told the demonstrator that his other sons are going to raise

a pig each this winter and spring, and showed him the pigs that have been selected from the stock that has been bred on the home farm.

Mr. Goodman reports 491 farm visits, 62 demonstration visits, 58 office calls, 760 letters written, 113 circular letters mailed, 12 meetings held (total attendance 596), 80 bulletins distributed and 16 articles published.

Passaic County, Ellwood L. Chase, County Superintendent

Farm demonstration work was started in Passaic County, May 11, with the employment of Elwood L. Chase as county superintendent. Two demonstrations were carried on showing the value of soybeans planted in corn for ensilage. The crops have been harvested and placed into the silo. The beans reached a height of 4 to 5 feet and were cut with a corn harvester and tied with the corn without trouble. The yield was 16 tons per acre on one meadow alone. Arrangements are being made to find out the feeding value of this crop as compared with ensilage from corn alone.

Eight farmers seeded alfalfa in accordance with the recommendations of the county superintendent. Although held back by dry weather the crop has come on nicely and will undoubtedly winter in good shape.

In coöperation with the extension specialist in soil fertility, J. B. R. Dickey, 15 plots for a seed trial of alfalfa were sown under field conditions.

Passaic County furnished 9 men and 114 cows to the Bergen-Passaic County Cow Testing Association. One man reported a saving of $4.00 a week and an increase in milk flow of 12 quarts a day from a change to a balanced ration as a result of studying cow testing association records and following the tester's suggestions. The county superintendent assisted in the formation of the Passaic County Dairymen's Association. The Association seems to be securing the recognition from the Paterson and Passaic Boards of Health, which will no doubt lead to the solution of one of the problems before the dairymen of that section.

Miscellaneous demonstrations have been conducted in the buying of improved cauliflower seed, use of green manure for the trucker and gardener and in soil improvement demonstrations.

Mr. Chase reports 446 farms visited, 132 demonstrations visited, 53 office calls, 211 telephone calls, 39 meetings held (attendance 1,099), 639 letters written, 60 circulars mailed, 20 bulletins sent out and 27 articles published in the local press.

Sussex County, Paul B. Bennetch, County Superintendent

Eight demonstrations were conducted to show the value of the use of formaldehyde in the prevention of oat smut. The farmers treated a large acreage, leaving in most cases a small check plot. The value of the practice was demonstrated successfully beyond question. The method is cheap and should be followed universally where smut is present.

This year demonstrations in the use of top dressing of timothy sods were continued. The results have uniformly been satisfactory and the practice is becoming well established in the county.

Work with the dairymen of the county has occupied most of the time of the county superintendent. The two cow testing associations are giving good results and have entered into their second and fourth year, respectively. Several interesting tests have been conducted to show the value of milk substitutes in the feeding of calves. Two calves dropped September 2 and 12, respectively, were fed until June 1, when they weighed approximately 600 pounds each. The cost was much less than with the usual milk feed; the entire cost for the feeding of one calf being $33.72 for the time indicated.

The question of the price of milk has been the most important one during the late summer throughout Sussex County. County Superintendent Bennetch and Assistant Extension Specialist Waller completed a farm survey among some of the dairy farmers a few weeks previous to the milk strike which showed that the cost of milk in Sussex County was just about the same as the farmers received for it. These figures were widely used in the campaign for public opinion which followed. The county superintendent was in great demand to attend organization meetings of the Dairymen's League, and officers of the league and leading farmers have expressed their appreciation of the intelligent help of the farm demonstration office through this trying time.

Miscellaneous demonstrations in Sussex County include the use of more leguminous crops, assistance in boys' and girls' club work, demonstrations in the use of salt as fertilizer, improvement of the dairy held by the use of pure-bred sires, poultry flock management, and orchard management. The last two demonstrations have been conducted on a rather extensive scale with good success.

Mr. Bennetch reports 803 farms visited, 315 demonstrations visited, 628 office calls, 83 meetings held (attendance 4,542), letters written, including circular letters, 3,949, bulletins distributed 514, articles published 45.

Automobile Inspection Tours

During the season the following counties have conducted successful automobile inspection tours: Bergen, Burlington (2), Mercer (2), Monmouth, Middlesex, Cumberland and Sussex.

REPORT OF THE EXTENSION SPECIALIST IN SOIL FERTILITY AND AGRONOMY

J. B. R. Dickey

Soil Improvement Demonstration

In traveling through New Jersey anyone interested in agricultural affairs cannot fail to be impressed by the large area of tillable land, adjacent to the railroads and markets, which is lying uncultivated, either given over to weeds, or entirely unimproved and covered with fire-stunted trees and brush. Soil maps and close examination show that much of this untilled soil is not inherently different from some of the most highly developed and productive

trucking soils of the State. As a matter of fact, there are many excellent farms and fields in these seemingly unproductive areas. The difficulty, therefore, apparently lies in the treatment which the soil has received and should for that reason be more easily susceptible of improvement. Almost all field investigation and laboratory research lead back to the conclusion that the elements needed to bring these soils to high productivity are organic matter, lime, nitrogen and phosphoric acid. Potash is also no doubt desirable on some of the lighter soils, but scarcely essential.

To demonstrate how these soil requirements could be economically met, work was undertaken in the spring of 1916. The plan was to select plots about a half-acre in size, having soils as nearly representative as possible of large adjacent areas which had never produced paying crops, or which through exhaustive cropping systems had ceased to give adequate returns; and after applying ground limestone and acid phosphate in moderate quantities, to grow and turn under leguminous crops, thereby supplying both organic matter and nitrogen. After one or more good crops had been turned under it was proposed to continue the work for two years with such cultivated crops as corn and potatoes, which would give a financial return and at the same time good opportunities for the growing of cover crops, by a consistent and systematic use of which the organic content of the soil could be maintained or further increased. The seeding down of the plots to clover or alfalfa has been considered as a conclusion for the demonstration.

To give actual, ocular demonstration of the poverty of the soil at the start and how much it could be improved by such a system of green manuring it was arranged in every case to have a check plot of equal size adjoining, which was to receive no treatment, but on which the money crops were to be grown and given the same care and cultivation, and the yields compared with those on the treated plots.

Two plots of new land were taken with a view to getting data and information on the costs and methods of clearing and bringing such land under profitable cultivation. The other plots were in various stages of abandonment, some having lain idle for a number of years. With one exception the twelve original plots were in the southern half of the State where the need for the work seemed greatest. The soils represented were mainly the yellow and gray sands, loamy sands and sandy loams typical of southern Jersey and classified as belonging to the Sassafras soil series of the Coastal Plain. One or two plots were located on the white sandy soils mapped as belonging to the Lakewood series, but no work was attempted on the poorer types of these white sands, on which the production of profitable crops is scarcely practicable even were it economically possible under average conditions. Such soils may have a use for poultry raising or other special industries, but their natural fertility and water-holding capacity is so very low, and there is so much vastly better idle land to be had at low prices, that the encouragement of their agricultural development does not seem wise. Plots were started in 7 of the southern counties besides one in Bergen County on a sandy loam soil of glacial origin.

Publicity of location was one of the prime requisites in selecting the plots and all are situated on some main road over which there is much travel,

where the attention of the public is attracted in most cases by suitable signs. Where the owner of the land was in a position to perform the necessary labor on the plots an agreement was made whereby the division of extension should furnish all seed, fertilizer and lime, and all crops removed from the land were to be turned over to the owner. In a few cases it was necessary to hire outside labor, and this was done by us where the desirability of the location warranted.

An effort was made to have the plowing done early in order to exercise some weed control measures and to give the limestone some time to act. As soon after plowing as possible the pulverized limestone was spread and harrowed in at the rate of 2 tons per acre, except in one case where the soil did not show much acidity, and 1 ton was thought sufficient. Beginning May 25 cowpeas were sown broadcast on all the plots at the rate of 6 pecks per acre and harrowed in as well as possible. Whip-poor-will and Clay were the varieites used and all were treated with commercial culture to insure inoculation. At the time of seeding 16 per cent acid phosphate was applied at the rate of 400 pounds per acre, except on one of the poorest plots where a 2—10 fertilizer was used.

The peas on all the plots save one grew in a satisfactory manner in spite of an unfavorable season, and on some of the best would probably have cut 1½ tons of hay per acre. On some of the plots sowed with the Whip-poor-will variety heavy crops of seed were matured, though it was thought desirable to plow before the full maturity, and on one plot the peas were picked from a measured area and the yield will be computed. The Clay proved a ranker and longer growing variety than the Whip-poor-will. Where a drill is not obtainable it would probably pay to sow at the rate of 2 bushels per acre to insure a good thick stand, since in harrowing in many seeds are wasted through improper covering.

The peas were plowed under in September and the plots were sowed to rye and winter vetch at the rate of 1 bushel of rye and 30 pounds of vetch per acre. The seeding was done from September 15 to October 3, and was delayed on account of the dryness of the soil. The vetch seed was inoculated with commercial culture. Where possible, a week or more was allowed to elapse between plowing and sowing to give the soil an opportunity to settle and a chance for decomposition of the peas to set in.

It is proposed next season to plow down the rye and vetch after they have made some growth and plant both treated and untreated plots in field or sugar corn, sowing a mixed cover crop at the last cultivation of the corn. The ears will be husked out, records made of the comparative yields, and the stalks and cover crop plowed the following spring for potatoes or some truck crop. Some further phosphatic fertilizer may be applied for the money crops, but the purpose is to use as *little nitrogen as possible*, depending on the leguminous crops turned under to supply this element. The limestone will make possible the growing of better leguminous crops, will take care of some of the acids produced by their decay in the soil, and by its action and the action of these acids it is thought that enough potash will be made available to supply the needs of the crops.

The usual method of maintaining the organic matter content of the soil in many parts of the State has been by the purchases of large quantities of

city manure. With the constant displacement of the horse by the motor in the city it is not surprising that the price of manure has risen and it may be expected to go still higher. With manure at $2.00 a ton a moderate application of 15 tons per acre would cost $30.00 and the labor of carting and spreading might easily bring the expense up to $50 per acre, which is putting a heavy charge against the crops to be produced. Lowering the cost of production is relatively as profitable as raising the price received. Practical farmers agree with experimental data that the returns from a good leguminous cover crop or green manure crop are about equal to those from a liberal application of stable manure, and the former is certainly much the cheaper of the two, especially if the seed is grown and saved at home, as can easily be done. Most South Jersey farmers have plenty of idle land which could well be growing a green manure crop yearly, and even if one were forced to forego one short season crop to provide space for the green manure, he would probably profit in a term of years through the saving in his manure bill.

During the past summer two more soil improvement plots were located in Ocean and Passaic Counties and rye and vetch was sowed on them in August. It is intended to continue locating these demonstrations as rapidly as good situations are found in all parts of the State, but especially in the more backward and more poorly developed sections where there is a large area of unimproved and idle land and where little live stock is kept. Already the plots started seem to be attracting considerable attention and comment, and several instances have been reported where neighboring farmers have adopted a similar system. Due credit should be given to the county demonstrators in the organized counties for their assistance in locating plots and coöperators and for their occasional overseeing and reporting on operations in the absence of the specialist. Constant supervision and following up by the specialist has proved necessary in this work in order to get the plowing, preparing and sowing done properly and at the right time.

Advisory Work in Soil Fertility

Frequent inquiries were referred to the specialist from parties who wished to know how to improve or build up land which they had purchased. Many other letters asking for information on lime, fertilizers, care of manure, green manure and cover crops have been answered and often followed up by a personal visit. The latter invariably seemed to be much appreciated, and by revealing actual conditions of soil, etc., enabled the specialist to give much accurate and specific advice as well as to explain thoroughly his recommendations, thus greatly increasing their chances of adoption and success. Advice was also given on cropping systems, methods of preparing for alfalfa, etc. Numerous letters were written to parties outside the State who inquired regarding suitable sections for particular lines of farming and regarding soil, climatic and market conditions in the State. These inquiries show that the eyes of the public are turning to the undeveloped lands of New Jersey and with such a variety of soils adapted to different types of farming, and some of them practically worthless, there will probably be a growing need for someone acquainted with the soils and

special industries of the State to direct prospective immigrants and give them disinterested advice.

A large part of this work was done in the unorganized counties, but days were frequently spent with the county demonstrators inspecting soils, and in other work. By providing his own means of transportation the specialist was enabled greatly to increase his visiting efficiency through making himself independent of railway connections, etc., and at the same time a great saving of livery and automobile hire was effected since most of the points visited were some distance from railway stations. A large number of the agronomy projects, such as variety tests of corn and soybeans, were also visited during the summer. With the exception of the alfalfa seed work, however, all the extension work in agronomy was in charge of Mr. A. G. Waller, assistant specialist in agronomy, and will be taken up in his report which follows.

Alfalfa Seed Tests

On account of the frequent inquiries and almost total lack of definite data on the subject, it was decided to conduct a test of alfalfa seed from different producing sections of different strains to determine, if possible, whether there are any especially adapted to the various soil and climatic conditions of this State. Disappointing results are often reported with alfalfa where every measure has been taken to insure success, and the evidence leads one to believe that the trouble may lie in the lack of vigor and hardiness of the seed used. A number of large seed houses were asked for seed, the source of which they could guarantee, and eight of them responded by giving seed from twelve western States as well as samples from Turkestan, South America and Russia. Six lots were of selected strains such as Grim and Baltic, and from all the largest producing states several samples were secured.

Through the coöperation of the demonstrators and the activities of the specialists 15 tests were arranged for in 12 counties, well distributed over the State, and on widely different types of soil. The seed was inoculated and about one square rod each of from 12 to 20 samples were sown in each test. These were located in fields of alfalfa which were being sown under favorable conditions with respect to lime and other requisites, and the test plots received no different treatment from the other parts of the field save sometimes in the matter of inoculation. The size, vigor, habits of growth, and longevity of the several strains will be noted from time to time rather than the actual yield in pounds of hay, as the latter is dependent on these factors. Although only a few inches high, differences are already apparent which may be expected to become more marked as time passes.

Summary of Activities

Office records from March 15 to October 15 show 329 letters written and 362 farm visits made.

REPORT OF THE ASSISTANT EXTENSION SPECIALIST IN AGRONOMY

ALLEN G. WALLER

The writer assumed his duties March 1, 1916. Projects of the previous year with corn community demonstrations, corn varieties and soybeans have been continued. New projects were added to demonstrate the value of sweet clover as a forage crop, Sudan grass as a forage crop and the use of soybeans with corn for ensilage, and one farm management project has been started.

Corn Community Demonstration

The project of the corn community demonstration was organized to show the difference in yielding power of the various types of corn in a community when grown under the same environment and treatment. This was done by collecting samples of seed corn from a number of farmers in the locality and securing one coöperator to plant two rows of each across his cornfield. In this way all the samples were given the same treatment with regard to fertilization and tillage. Then at harvesting time the yield from each was weighed and a field meeting held to point out the different variety characteristics as well as the more desirable varieties.

There have been five of these demonstrations under the direct supervision of the writer, in the unorganized counties of Salem, Gloucester, Camden, Hunterdon and Warren. The number of samples in any one demonstration ran from 17 in Salem County to 27 in Hunterdon County. In all instances there was a wide variation in yield which must be due largely to the seed, since the other factors affecting yield were as nearly alike as possible.

The lowest variation in these community demonstrations was 21 bushels per acre, which was obtained at Mr. J. Herbert Brown's farm near Swedesboro, in Gloucester County, with the yields ranging from 53 to 74. The largest variation was 47 bushels per acre which was the result in Warren County on Mr. L. C. Mackey's farm near Belvidere. The per cent difference in yield of the highest and the lowest ranged from 40 per cent in Gloucester County to 106 per cent in Hunterdon County.

The very fact that the most uniform yield of different farmers' seed corn planted and grown under the same conditions showed a difference in yielding capacity of 21 bushels per acre, leads to the conclusion that there must be a certain strain for any given locality which is the best for local conditions. It would require a more extensive project running for several years to demonstrate what would be really the best variety.

However, this project promises to be of sufficient interest to corn growers to warrant its being carried on, in such a way as to demonstrate the best yielding varieties for the county in which it is conducted. A number of farmers in Gloucester and Warren Counties have volunteered to coöperate in making this a definite project for a number of years.

At these corn meetings there has been an average attendance of 35.

Corn Variety Work

The project of corn varieties was carried on to demonstrate whether there are certain pure strains or varieties which could be profitably grown more extensively in New Jersey than heretofore.

There have been 10 standard varieties tried out in various parts of the State this past season, by 27 different men, representing 8 unorganized counties and 3 organized counties.

These varieties have, wherever possible, been grown in connection with the corn community demonstrations. One of the striking results was that in almost every instance the imported standard varieties were among the lowest yielders, giving from 13 per cent to 26 per cent less than the average yield of the local strain. This is not unusual, but it tends to demonstrate the fact that the best yielding variety of corn for a community or county should be developed from the strains already grown in that section.

Another interesting fact was shown at the Belvidere demonstration, where the 5 flint corns gave an average yield of 85 bushels per acre, while the 13 dent corns averaged 93 bushels per acre. This demonstrated that on good fertile soil in that locality, some early maturing dent would be preferable to the flints, but on light, poor soils the flint might be better.

Of the varieties grown, the Improved Leaming and Silver King are to be recommended in New Jersey, north of New Brunswick; south of Trenton, the season's work has shown that Boone County White and Reid's Yellow Dent are to be recommended.

Sweet Clover

To demonstrate the value of sweet clover as a forage crop in New Jersey, with special reference to its use on the poorer soils, a sweet clover project was started, with 18 coöperators from 9 different counties. The plots were ⅛ acre in size, and seeded at the rate of 25 pounds per acre as early in the spring as possible. Lime was used wherever possible, and the treated plots showed a decided advantage over the unlimed plots; in 2 instances the value of inoculation for sweet clover, where the soil is not already inoculated, has been clearly shown by the yellow and sickly looking plants where uninoculated.

It has been noticeable that in nearly all cases the stand of clover has been marred by a strong growth of weeds, due, no doubt, to the slowness of sweet clover to start. However, with the first cutting of the plots this fall the weeds will be checked, and the crop next season should be more nearly pure clover.

Sudan Grass

A project with Sudan Grass was started to demonstrate its value as a forage crop in New Jersey, and 5 men coöperated in growing this. The plots were ⅛ acre in size, and were seeded broadcast about corn-planting time or shortly after, at the rate of 25 pounds per acre. Quantitative results can not be given on this project, but it has demonstrated that Sudan grass is of value for forage in the southern part of New Jersey where an annual forage crop is needed.

Alfalfa

Investigation of the project begun in 1915 with square rod alfalfa plots showed that, though these plots have aroused some interest in the crop, it was not sufficient to warrant continuing the project.

Soybean Projects

Work with soybeans has been carried on to demonstrate their value in the State for seed production, hay and silage. The number of coöperators has been 24, representing 8 unorganized and 5 organized counties. There have been used 8 commercial varieties and two furnished by the Bureau of Plant Industry of the U. S. Department of Agriculture.

SILAGE. The demonstration of mixing corn and soybeans for silage has been quite successful during the past season. It has been carried on by 9 coöperators in 6 different counties.

When planted in the same row with the corn the mixture was at the rate of about 4 quarts of soybeans and 6 to 8 quarts of corn per acre. The soybeans have also been planted apart from the corn and then mixed with it when filling the silo. It has been shown that under good soil conditions and tillage, the practice of growing soybeans in the corn row may be a good one, with the idea of securing a richer silage, as well as enriching the ground.

When planted in the same row with the corn, north of Trenton, the Wilson, Hollybrook and Medium Green varities were most satisfactory in habit of growth, and reached the proper state of maturity at the time of silo filling.

SEED PRODUCTION. The work this season has been hindered by the late spring which prevented a number of the 12 coöperators from getting the soybeans planted early enough. From the figures at hand, and observation, the Ito San, Medium Green and Wilson varieties will produce seed satisfactorily in New Jersey.

HAY. For the production of hay, with the varieties used this season, the Wilson has shown to good advantage. As there were only 3 coöperators in this demonstration, no very conclusive results can be given.

Farm Management Work

COST ACCOUNTS. A number of farmers in Mercer and Middlesex Counties have started cost accounting books to determine just what it costs to carry on each farm crop or enterprise. The writer has 11 of these accounts under his personal supervision. These accounts will not be closed until the spring of 1916, so no results or figures can be given at this time.

FARM SURVEY. At the request of the Sussex County Farm Bureau, 57 farm records were taken with the aid of Mr. Bennetch in the northwestern part of the county along the Delaware River, just below Port Jervis. This farming section is well divided between poultry raising and dairying. The survey was taken with the idea of demonstrating the more profitable of the

two types of farming and the reasons why, as well as the proper farm organization in this particular locality.

As soon as the field work in crops has been finished, the data from these records will be studied to show the most profitable type of farming and the best organization for these farms. This information will be returned to the farmers in the form of a circular.

REPORT OF THE EXTENSION SPECIALIST IN MARKET GARDENING

R. W. DeBaun

During the past year the interest of the practical vegetable growers throughout the State has been attracted by the economic value of the projects which were advocated by this division. By carefully investigating the vegetable growing practices as found in the various parts of the State the extension specialist, with the assistance of the farm demonstrators, has been able to devise and formulate certain ideas and methods in vegetable growing which are based upon proven practical methods and upon scientific investigation. The division believes that those projects would be of lasting benefit to the various communities if they were incorporated into the work of the various growers. Therefore, during each year a certain few of the projects are brought to the attention of the people by means of demonstration plots, bulletins, letters, news articles and lectures. The introduction of any procedure that would not prove to be economical and thoroughly practical for the man who has to make his living from what he grows has been carefully avoided.

During the year just past the extension specialist delivered addresses on some phase of vegetable growing before 83 meetings with a total attendance of 6,038, and wrote 1,141 letters. A circular has been written on asparagus, 45 articles have been published in the Weekly News Letter of the extension division, and 300 lantern slides have been made for lecture work. The demonstrations carried on are as follows:

Cantaloupe Growing

Cantaloupe growing is an important industry in New Jersey. The great drawback is the blight which destroys the vines when the fruit is approaching maturity. Furthermore, the spray materials which are frequently used to prevent the blight cannot always prove efficient, due perhaps to the improper soil conditions, devastation by insects or to improper or insufficient fertilization. A complete project on the growing of cantaloupes was formulated, embracing the proper preparation of the soil and the use of insecticides, fungicides and special fertilization.

This work was taken up by the farm demonstrators of Bergen and Mercer Counties with several coöperating growers. Splendid success was obtained in most places. A grower near Lambertville, Hunterdon County, received a complete outline of this project last spring. A letter was rereceived from him this September saying that he had such results from following the outline of the project that he felt impelled to write and thank the extension division for enabling him to make about three hundred dollars extra on his cantaloupe crop this season.

Rust-Resistant Asparagus Plants

During the last decade the U. S. Department of Agriculture has been endeavoring to develop rust-resistant asparagus. It has succeeded in its effort, and this spring the extension specialist in market gardening was notified that a limited quantity of one-year-old roots was ready for free distribution among the States. The propagators were reminded that New Jersey grew twice as much asparagus as any other State excepting California, and wanted all it could obtain. Three thousand fine roots were sent us and a large part of them were allotted to the county demonstrators for distribution in lots of fifty roots to each coöperator. An effort was made to give the roots to those men who were planting new beds at the time so that there would be a good opportunity for comparison. A careful record of this distribution has been made so that the test plots can be followed up and examined by an expert in years to come. Thus the definite relative value of the distributed roots will be compared with the ordinary varieties.

Winter-Sowed Spinach

Spinach is a quick-growing heavy-producing crop that can be grown before or after our regular truck crops. The prices are usually good so that the crop should be a very profitable one when certain points regarding its culture are more thoroughly understood by our truckers. With the idea of demonstrating its quick growth and profitableness in extra early spring, three demonstration fields were planted last February in a special manner under the directions sent out from this office; two of them in Burlington and one in Cape May County, all under the direct charge of the respective farm demonstrators.

The seed sprouted very early in the spring and the crop was ready to harvest 10 days earlier than it would have been if planted in the usual time in the spring. Mr. Henry Reeves, of Erma, Cape May County, reports that his planting netted him about $150 per acre. The H. L. Lippincott Co., of Riverton, had similar success with their planting, and Mr. P. H. Burke, of Riverton, reports that although the seed which he used was poor, his crop was quite a success and he will increase his planting hereafter.

Avoiding Sweet Potato Diseases

Investigation by the U. S. Department of Agriculture has established the fact that many of the diseases which develop in the sweet potato field are carried over in and on the seed, and are brought to the field on infected sweet potato plants. Therefore, acting under recommendations made by that department, a definite procedure was formulated, which provided that every reasonable precaution be taken to select uninfected seed at digging time and that the seed be disinfected before it is bedded in clean soil the next spring. This work was begun last fall and excellent results have been obtained in Atlantic, Cape May, Burlington and Cumberland Counties, with many coöperators working with the respective farm demonstrators. This

work will be enlarged in these counties the coming year and the extension specialist will be able to get the work started in the unorganized counties of Camden, Gloucester and Salem.

This work is of a great economic value to the State. The sweet potato crop is worth approximately $3,000,000 annually. From 10 to 35 per cent of the plants die in the fields from the diseases, but when proper precautionary measures are pursued the percentage of dead plants is usually less than 5 per cent the first year, and even this amount is decreased in succeeding years as the seed becomes cleaner. Furthermore, the crop keeps better in storage.

Horseradish Work

The work with horseradish growers in Burlington County has been pushed forward this year upon a larger scale than last year. In that county large plantings are made. The original set, or root, is allowed to send out side roots and leaf hearts at random. A process called stripping is recommended. It consists of pulling off the side roots along the upper half of the original set and of cutting off the extra leaf hearts which impair the culinary value of the root. If this work is done at a certain stage of the growth a much finer and larger root will be developed for the markets.

Seven growers are carrying on this stripping test under the direct supervision of the farm demonstrator and the extension specialist while several other growers in this county and various parts of the State are running private test plots along the lines suggested by this office. When digging time comes, it is planned to call meetings of the local growers in Burlington County so that all may see the results of the demonstrations.

One test is running in Cape May County and promises to produce excellent results. If better methods for growing this crop can be introduced and adopted by our growers, New Jersey should soon become the foremost horseradish State, instead of the third.

Tomato Spraying

The success obtained from spraying test plots of can house tomatoes in Cape May County in 1915 attracted the attention of growers and canners from all over the State. Under the direct supervision of the farm demonstrator of Cape May County and the extension specialist, tomato spraying was carried on in two communities on an extensive commercial scale. A complete record will be found in the report of the farm demonstrator from Cape May County.

Demonstration plots were sprayed by the respective farm demonstrators in the following counties: Cumberland, Atlantic, Bergen and Morris, and the results obtained will be reported by them. There was one demonstration plot in the unorganized counties. It was at Stockton, Hunterdon County, on the farm of Mr. C. W. Lines. Due to the weather conditions, little difference between the sprayed and unsprayed sections developed.

Onion Maggot Preventive

The onion industry in New Jersey is very extensive and the destruction from the onion maggots has frequently been severe. These small white maggots hatch from eggs laid by the adult fly in the onion field during early spring, and live, feed and develop under ground where it is quite impossible to check their destructiveness after they once become established. Recently State Entomologist Sanders, of Wisconsin, developed a scheme whereby the adult fly may be killed during the mating season. A cheap soluble poison sweetened with molasses and flavored with onions is used.

This method was tried under the supervision of the farm demonstrators in Cumberland, Mercer and Monmouth Counties, and by Mr. Theo. Brown, of Gloucester County, coöperating with the extension specialist. The results obtained were encouraging, and the work will be developed with more coöperators another year.

Sweet Corn Work

Two very important features of sweet corn growing have been demonstrated during the past season, namely, the effect of removing the suckers at various stages in the growth and the economic value of dusting the newly developing corn silk with arsenate of lead so that the corn ear worm might be destroyed before it begins its destructive work.

Results obtained by suckering the sweet corn this season in Burlington, Middlesex and Bergen Counties substantiate the results of the work done last year in Bergen County. The suckers should be removed from the sweet corn when they are about six inches long. This treatment causes a sturdier growth and results in earlier maturity by a few days. There seems to be no advantage in suckering twice, and to sucker late in the growth of the corn reduces the yield, especially when there is sufficient moisture in the soil to support considerable foliage.

Demonstrations in controlling the corn ear worm were carried on in Atlantic, Cumberland and Cape May Counties by the county demonstrators. The results indicate very clearly that the insecticide will prevent the infestation to a very marked degree, but there is need at the present time for a better implement for applying the material.

Miscellaneous Demonstrations

During the season various demonstrations were made in the unorganized counties so that the value of each as a permanent State-wide project might be tried out. The following are some of especial interest.

A celery spraying demonstration to control the blight with Bordeaux on infested soil by beginning the spraying when the seedlings first come up was carried on by Mr. Henry Dreyer, of Union County. The work was done very accurately and perfectly healthy celery was grown. This indicates that if the plants are kept free of infestation before they go to the field, they have the best opportunity to develop a good crop.

Onion thrip control with tobacco extract was tested out in Gloucester and Cape May Counties in coöperation with the entomology department of the

experiment station. Ten days after the treatment was applied the growers saw a marked difference between the sprayed and unsprayed sections of their fields. The growers were so well pleased with the results that they have decided to spray regularly another year. However, this project will not be strongly advocated another year, because in all probability most coöperators would not do the exacting work carefully enough.

A tomato variety test was conducted at Lambertville, Hunterdon County. The Bonny Best was very early, and a heavy producer of fine quality, nicely-colored fruit. The Greater Baltimore proved to be about a week earlier than Stone. The color and solidity of the former were unsurpassed and the yield very satisfactory.

Melon aphis control with tobacco extract was carried out very successfully in the southern part of the State on more than a dozen farms.

Disease-resistant cabbage seed was tested out in Burlington County on disease-sick soil under the direct supervision of the plant pathology department of the experiment station with excellent results. Therefore, this project might be developed for another year if sufficient amount of disease-resistant seed can be secured for demonstration purposes.

During the season frequent visits were made to the Brookdale School Garden, in Bloomfield, and to Kenyon Gardens, in Plainfield. Assistance was given to the teachers so that the children would find their work more interesting. The specialist judged the home vegetable gardens in the Sussex County contest and in the New Brunswick contests where several hundred children had home gardens in competition for many prizes.

The extension specialist in market gardening delivered an address before the Connecticut Vegetable Growers' Association at Hartford, Conn., and represented the New Jersey State Horticultural Society and the State Agricultural College at the annual convention of the Vegetable Growers' Association of America held at Chicago, Ill.

REPORT OF THE EXTENSION SPECIALIST IN FRUIT GROWING

L. G. GILLIAM

The work of the past year, since February 1, 1916, has consisted in carrying on different projects in organized and unorganized counties, personal visits to farms, preparing and staging fruit exhibits, judging exhibits at fruit shows and in attending farmers' gatherings and the meetings of fruit growers' associations, where talks and demonstrations have been given.

A traveling set of lantern slides, together with an outline covering the slides for the use of demonstrators or other extension men, has been prepared during the year. These slides include the important points relating to fruit culture.

A fruit exhibit for county agents, consisting of charts, different types of pruning shears, spray nozzles, etc., has been prepared and sent out.

Orchard Management Demonstration

One of the chief aims of the horticultural department has always been to demonstrate the best methods of management in peach and apple orchards throughout the State. This work, begun by Mr. A. J. Farley and continued by Mr. W. W. Oley, both of whom have served as specialists in fruit growing, constitutes the main portion of the year's work.

At least 5 orchards were selected by the demonstrator in each organized county. The extension specialist assisted with this work in these counties when requested, besides conducting 6 demonstration orchards in counties having no agents. Special demonstrations in pruning, spraying, packing and marketing were held at these orchards.

Much work has been done in Sussex and Bergen Counties where satisfactory results were obtained in the 15 orchards selected. The success in these counties was due in a large degree to the coöperation of the farm demonstrators and orchard owners.

Special Peach Pruning Demonstration

This project was conducted to demonstrate that a certain amount of cutting back of the growth of peach trees is desirable. This method of pruning was followed in all demonstration peach orchards and in several orchards in certain important peach growing districts where the trees formerly have been pruned according to the method of thinning out branches, but where no cutting back of branches has been practiced. During the past season the advantages of the cutting back method have been clearly pointed out in several sections of the State.

The Dusting of Apples

Considerable work has been done in the dusting of apples in Sussex County. The work has been conducted to determine if dusting is a suitable substitute for liquid spraying in the control of insects and fungous diseases in the northern counties of the State. The project was confined to one county until its practicability could be demonstrated in these hilly sections where spray tanks are handled at a disadvantage and where the long hauling of water is a big item.

Through the coöperation of Mr. P. B. Bennetch, county agent, the orchards of Mr. Edwin Halsted and Mr. Adamson, near Newton, were selected for this work. The assistance of these men aided in the successful carrying on of the work. Mr. F. E. Pough, of the Union Sulfur Co., New York City, made the work possible by loaning the dusting machine and donating the material used, besides being present at several of the applications.

The material used was a mixture of 85 per cent sulfur and 15 per cent lead arsenate dust. In the Adamson orchard a block of 46 25-year-old Baldwin trees was treated with the dust, the same number were sprayed with liquid lime-sulfur, and several rows left untreated as checks. Four appli-

cations of the dust and spray were made to each block in this orchard at the regular spraying periods. In the Halsted orchard a block of 32 old trees of different varieties was dusted and 28 trees sprayed. Three applications of dust and spray were made in this orchard. Complete records of amount of materials, labor, time, weather conditions, etc., were kept. Although complete results have not been secured at this time, as most of the fruit is still unpicked, indications point to equally successful control of insects on the dusted blocks as on the liquid spray blocks, and almost equal control of scab where dust was used. While the total cost is practically the same, with a slight advantage in favor of the liquid spraying, the great advantage of the former is in the time saved and ease of application, the dust being applied in one-third to one-fourth the time of the liquid application. Where large orchard acres must be treated in a short length of time this method of insect and fungous control can be recommended.

Summer Spraying of Peaches

On the peach orchard of Barton Brothers, near Marlton, the value of a new summer spray for peaches, consisting of a mixture of sulfur, glue and hydrated lime as a substitute for self-boiled lime-sulfur and other commercial sprays, was demonstrated.

This mixture was applied three times to four rows of the Greensboro and Carman varieties, numbering approximately 80 trees, while the remaining trees, numbering several hundred, were treated with a commercial spray used extensively in Burlington County. The new mixture was applied May 18, just as the shucks were slipping, and again on June 3 and June 24.

On July 20, just as the Greensboro were ready to pick, and again on August 4, before the Carman were picked, observations of the block of trees which were treated with the new mixture showed the fruit to be practically free from scab and brown rot. The trees sprayed with the commercial preparation received one less application, but showed large quantities of scab and some brown rot. The effectiveness of this material as compared with atomic sulfur as a summer spray for peaches shows this mixture to be equally as good at a much lower cost. The exact method of preparation of this mixture will be discussed in a circular to be published later by the extension division.

Packing and Marketing Peaches

In several different sections of the State demonstrations in the packing of peaches in Georgia carriers were held. Some of these demonstrations were regularly advertised demonstrations, but the most effective work in this line was in the form of personal visits to farms at picking time, since during this busy season growers were seldom able to attend regular demonstrations.

Besides the actual packing work, considerable time was given to the proper package for the marketing of good fruit. In two sections of the State a demonstration in the marketing of peaches in Georgia carriers was given. This project often necessitated several days' work before the advantage of this form of package could be shown. The purpose of this

demonstration was to show that in certain sections of the State peaches may be marketed more profitably in Georgia carriers than in ordinary peach baskets if a desirable market is selected and the fruit properly packed.

In Bergen County this work was carried on with fruit from a 5-year-old demonstration orchard on the farm of Mr. Tice, at Westwood. The fruit previously had been sent to Paterson in 16-quart peach baskets. Under the direct supervision of Mr. L. F. Merrill, county demonstrator, and the extension specialist, several Georgia carriers were packed and shipped to a commission house in New York City. A special trip was made to New York to see this fruit sold, and it brought from 40 to 50 per cent more than the same amount of fruit in baskets in the Paterson market.

Several days were spent in the 4-year-old peach orchard of Arthur J. Collins and Son, Moorestown, instructing in and demonstrating the uniform three-tier Georgia pack. The packers had previously been using a variety of packs. The orchard comprises 7,500 trees in a single block of the following varieties, Waddell, Carman, Champion, Hiley, Belle of Georgia, Reeves' Favorite and Elberta. Mr. Collins had been sending all of his earlier varieties to the Philadelphia market in crates and baskets when his place was visited on August 24. Previous to this time he had shipped about 3,000 crates to Philadelphia. Fruit of the same size and quality was bringing much better prices in the New York market, and on the advice of the specialist in fruit growing, arrangements were made by Mr. Collins to try the New York market, and an auto truck was secured to transport the fruit. Shipments were begun the following day. A total of 1,903 crates were sent to New York, and of this number 1,202 crates were Elbertas. During the season several shipments were made to the Philadelphia market, so that a comparison of prices between these markets was easily secured. Throughout the season it has been estimated that the prices per crate in New York ran from 30 to 40 per cent higher than in Philadelphia, with a slight additional expense for transportation. Mr. Collins is very well satisfied with the results obtained this year and plans to continue the shipping of peaches in carriers to New York another season.

During the height of the shipping season several trips were made to the New York market in company with the State Horticulturist and several growers to note the condition of Jersey fruit upon arrival and the manner in which it was sold. Reports were then made to the growers interested. These trips showed the importance and necessity of growers keeping in close touch with market conditions during the shipping season.

Budding and Grafting Work

During the present season numerous requests have been received for information as to the proper methods of top-working peach trees. These requests have been taken care of whenever possible and demonstrations given. The work has consisted in budding seedings of worthless varieties to well-known commercial varieties during the last of August and the first of September. Top-working of apple trees by means of cleft grafting has likewise been demonstrated in certain sections.

Lid-Nailing Press for Peach Crates

Last year a machine was devised by Mr. Schieferstein and Mr. Cowgill for lessening the labor of pressing down and nailing the covers on peach crates. Demonstrations in the use of this press were given by Mr. Oley, and it was distributed among many peach growers throughout the State. Six presses have been made during the past season by Mr. Haines, of the extension division, who has made several minor improvements. These presses have been placed with several large peach growers, and through saving much time and labor have given complete satisfaction. Special mention might be made of the work done by this press at the orchards of A. G. Donald, Edgewater Park, and of A. J. Collins & Son, Moorestown, where several hundred crates were handled daily. Full particulars regarding the process of construction, material needed and sketches of parts will be prepared and published later in bulletin form.

Summary

During the present season, since February 1, 1916, 474 farms have been visited, 314 letters written, 54 meetings held, with a total attendance of 1,168. Of these meetings 48 were pruning, spraying and packing demonstrations, with a total attendance of 732. Part of these demonstrations were held in coöperation with county demonstrators and include Mr. Haines' work.

Work has been started in an effort to control borers in peach trees. Experiments are being conducted on several trees of various ages in the orchards of John H. and Kenneth Hankinson, Glen Moore, Mercer County. This work is being done in coöperation with Mr. Hamilton, county agent, and is not yet completed.

Fruit survey work to be done during the winter months is being planned for certain large fruit sections of the State.

The assistance of Mr. H. C. Haines has been helpful in carrying on the extension work during the present year.

REPORT OF THE EXTENSION SPECIALIST IN POULTRY HUSBANDRY

Victor G. Aubry

This year following along the same line of effort as last year, we were able, with systematic methods and with a better knowledge of the field, to cover more territory and to accomplish work in a more satisfactory way. A larger portion of the time has been put on *demonstration project work* this year than last, with profitable results. This project work as systematized is made up of six major projects and nine minor projects, as described below.

Major Project 1: This consists of six kinds of work, (1) caponizing, (2) killing, picking and packing market poultry, (3) candling, grading and packing market eggs, (4) operation of incubators, testing of eggs, packing hatching eggs for shipment, (5) operation of incubators and brooders, (6) culling pullets for layers, culling and mating breeding stock.

Major Project 2: Organizing local poultry associations. The idea followed out here is a system of organization which is uniform throughout the State, and conforms to the foundation laid by the State Poultry Association. The fact that the organization has four main purposes, (1) education, (2) coöperation, (3) legislation, and (4) publicity, tends to make organizations permanent, and, therefore, more beneficial.

Major Project 3: Organizing boys' and girls' chicken raising contests and poultry clubs. This work is carried on through the coöperation of the State leader of agricultural clubs, the county public schools, the county farm demonstration officials, the local poultry associations, the United States Department of Agriculture, and the poultry department of the experiment station. A uniform set of rules, entry blanks, record blanks, and report blanks are used in this work.

Major Project 4: Winter egg production, or the management of the laying flocks. Balanced and efficient, yet simple laying rations are used, the proper principles of housing layers are followed and efficient systems of management are practiced, which include simple, yet complete records.

Major Project 5: February, or early hatching. The purpose of this project lies in the idea of securing a small percentage of the laying flocks earlier than usual, which will supply eggs in the late summer and early fall when hens begin to stop laying, and later hatched pullets have not as yet matured. A simple, yet complete set of laying, incubation, brooding and rearing records accompany this project.

With both Major Projects 4 and 5, an attempt is made always to have check flocks for the purpose of more strongly emphasizing the important features of the original project.

Major Project 6: Pedigree breeding. This project is conducted with a purpose of intelligently and efficiently improving the poultry stock whether with a small farm flock or on a large specialized poultry farm. In this project the trap nest is systematically used, and practically the whole flock is trap-nested at a minimum of labor and records. The very best of the flock is employed for breeding males to be used in the main flock the following year.

The minor projects are outlined in the following paragraphs.

Minor Project 2: Housing. The proper principles of poultry house construction are applied either to the construction of new houses, to old poultry houses, or to farm buildings being remodelled.

Minor Project 3: Feeding sour milk skim to chicks, layers, breeders and growing stock. The aim of this project is to impress the farmers and poultrymen with the great value of this product as a feed for poultry. When desired, records are furnished with this project and check pens are run showing the difference in mortality, vigor, stamina, production and uniformity of those pens fed sour skim milk and those fed in the ordinary way.

Minor Project 4: Feeding chicks and growing stock granulated bone. This is fed in their mash at the rate of 5 per cent, and also in a pure form in a hopper. With this project, as with minor project 3, an attempt is made to have records kept and check pens used for comparison.

Minor Project 5: Animal proteins in rations for laying birds. A ration containing 20 per cent of a good grade of meat scrap is fed to laying

birds, egg records kept, and check pens fed. Various amounts of meat scrap also are kept. The object of this project is to ascertain what percentage of meat scrap or animal protein is best for egg production under various conditions.

Minor Project 6: Feeding an abundant supply of succulent feed to laying flocks. This is important, especially during the winter, when flocks are more or less confined. An attempt is made to keep records and check pens in this project also.

Minor Project 7: Developing pullets for winter eggs. Hatching at the proper season, the continual development of pullets from weaning time until maturity by proper range conditions and feed, and the selecting and housing of pullets in due season, are features of this project.

Minor Project 8: Use of commercial milk powders and milk albumin. A good commercial product of milk powder is used as a supplement to the regular chick and developing rations, or commercial milk powder or milk albumin is substituted for the sour skim milk used in minor project 3. In many sections of the State the extremely high cost of skim milk prohibits its use as a chick feed. These commercial milk powders and milk albumins are substituted. Records and check pens are used with this project whenever possible.

Minor Project 9: Fattening poultry for market. Roasters, broilers and fowls are crated for ten days or two weeks. Special rations are given to the birds, and feed and price records are kept for birds fattened and check lots.

Minor Project 10: Comparison of methods. Observations are made on farms where systems and practices are used other than those advocated by the experiment station. As often as possible, records are kept of egg production, feed cost, incubation, brooding, etc. These records are then compared with records kept in the other projects.

The projects are divided into major and minor projects because the major projects require constant supervision, both by the county farm demonstrator and by the extension specialist, while the minor projects require but one or two visits to each of the coöperators.

From time to time both the major and minor projects will be added to as experience develops new fields. For this reason detailed outlines of these projects have been sent out to the various county agents, in loose leaf form for their files, to which additions can be readily made.

Detailed Reports of Projects

Although formulated comparatively recently, most of these projects are at present being run in different parts of the State, and some of the records of the major projects are included in this report. In the minor projects, where records are seldom required, only temporary or outstanding conclusions can be made.

Under minor project 2, there were 127 new multiple unit laying houses built at an average cost of $1.20 per bird, allowing 4 square feet of floor space per bird, and figuring labor at 20 cents an hour. The lowest cost recorded was 83 cents per bird. Of the old houses remodelled, or farm build-

ings remodelled, there were 176. The cost of remodelling varied greatly, the lowest being 10 cents per bird, and the highest 73 cents. This makes a total of 303 demonstrations of minor project 2.

Four coöperators conducted minor project 3. In the four pens there were 700 chicks, 2 pens of 250 each, and 2 pens of 100 each, all single comb White Leghorns. With these pens, one of the 250-size, and with both of the 100-size, check pens were conducted. Although only observation records were kept, there was a marked difference between these skim milk pens and the check pens, there being a decided improvement in the skim milk pens with respect to size, vitality and uniformity, and fewer chickens died. Because of the extremely high price of skim milk in most counties of the State, it was considered unwise to run more of these projects. In most cases the skim milk powders were substituted, as reported under minor project 8.

Only 3 demonstrations were conducted under minor project 4, and 2 of these were failures, because it was impossible to find, on short notice, any granulated bone of good quality.

It was found that almost all farmers and poultrymen fed animal protein in the form of good meat scrap, and that most of them fed this ingredient in their dry mash at a rate of between 15 and 25 per cent. In two cases where we conducted check pens, we found our maximum egg yield when 20 per cent was fed. In all instances where records were kept on a ration containing more than 25 per cent meat scrap, we found that the flock, although producing very highly at certain periods, would at times fall very low in their production, due in almost every case to digestive disorders, and in a few cases to colds and even roup. It should be noted that in each of these cases, also, the coöperators gave their flocks but very little extra attention, because they were otherwise occupied and the writer believes that although with special care more than 20 per cent meat scrap would result in profitable returns, in general, with ordinary conditions under which poultry is kept, 20 per cent meat scrap in the ration should be the maximum.

Under minor project 6 no records were kept of the coöperators, because it was found that almost all poultrymen and farmers practiced this method. Advice was given in many cases, however, for the kind, amount, and manner of feeding to many farmers who afterward found the recommended practices very good. Plans are now being made to change this project to a certain extent, and to require egg records to accompany it. An effort will be made to ascertain the most economical succulent winter feed for hens in different parts of the State, both in regard to cost of production and cost of feeding.

Conditions in regard to minor project 7 were found to be very similar to those for minor project 6, *i. e.*, practically all farmers raised their pullets on range. Here again, however, suggestions were given in regard to improving the ranges already used, or selecting a more desirable location on the farm for this project.

Because of the high price of skim milk, especially in the southern counties, it was thought that a considerable saving would be made in substituting for this commodity various prepared skim milk powders, and many farmers were found who would conduct this project. The result this year shows that over

50 coöperators carried on this project, and, with but one exception, favorable results were obtained as with the skim-milk project. Larger chicks were obtained, more uniform flocks and less mortality. The exception was obtained in one case where an attempt was made to substitute the commercial powders for all of the meat scrap in the chick rations. A slight increase was recorded in mortality, due principally to the development of the habit of toe picking. In all other cases the regular amount of meat scrap was left in the ration and 10 per cent of milk powder was added. Next year records on mortality, size of chicks, and cost of raising will be kept as well as records on the maturing of pullets from broods fed these products.

No work was done on minor project 9. We were able to get 8 coöperators to conduct minor project 10, and these records, when completed November 1, will be compared with those kept on neighboring farms where experiment station methods were used.

Major Project Results

In major project 1, 19 demonstrations were given of caponizing, with a result that many more farmers, especially in districts where heavier breeds are kept, are able to hold over profitably some of their surplus cockerels. Four demonstrations in killing and picking were given, resulting in greater returns for a well-dressed carcass where killing was already practiced, and a utilizing of wasted time on the farm where it was not a practice to dress poultry for market.

Four demonstrations on candling and grading eggs were given, which followed the establishment of a small retail trade for the farmer. At the same time demonstrations on testing eggs during the incubation period were given, 8 demonstrations on culling pullets and 7 demonstrations on mating breeding stock. The demonstrations in this project were presented in the following manner. First a lecture was given in which the advantages of these practices were pointed out. Then a talk was given and illustrations shown to explain the technique of the operation. Following this the specialist would conduct three or four demonstrations, and then the people present were allowed to perform the operations under the supervision of the specialist.

Under major project 2, two local poultry associations were formed, one at Egg Harbor, Atlantic County, and one at Montague, Sussex County. The association at Egg Harbor developed very rapidly. They have held meetings twice a month; have had a lecture at every meeting; have bought 5 carloads of feed to date, and are at present receiving regularly 2 carloads of feed a month.

Major project 3 was carried on in Ocean County alone, in which 56 boys raised chicks in competition for prizes offered by various county organizations. Each contestant hatched and raised 25 chicks, and at present there is an aggregate of 840 chicks owned by the boys. A judging team was selected to go to Springfield, Mass., during the National Dairy Show.

Major project 4 was carried on at 3 places in Sussex County, 1 in Bergen, 5 in Middlesex, and 1 in Warren County. One of the sets of records of this project follows, space allowing only this one, and totals are given instead of the records in detail as kept by the coöperator.

Major Project 4. Conducted by August Weiss, Upper Saddle River, N. J.

Breed—White Wyandottes

DATE.	No. of Birds.	Feed. Amt. lbs.	Feed. Cost.	Eggs. No.	Eggs. Amt. Rec'd.	Above Feed. Profit.	Above Feed. Loss.	Labor. No. Hours.	Labor. Cost.	Miscellaneous. Expense.	Miscellaneous. Receipts.	Net. Profit.	Net. Loss.	Remarks.
Nov., 1915, ...	79	656	$11.36	355	$14.20	$2.84	....	13.0	$2.60	$1.35	$1.50	$0.39	....	
Dec., ...	78	636	10.76	829	33.16	22.40	....	14.5	2.90	0.60	1.50	20.40	....	
Jan., 1916, ...	78	612	10.64	924	33.04	23.00	....	14.5	2.90	0.60	1.25	20.75	....	
Feb., ...	78	743	13.26	1,081	35.43	22.17	....	13.5	2.70	0.60	1.25	20.12	....	A number of eggs broken and eaten.
March, ...	78	779	14.01	1,380	37.48	23.47	....	14.5	2.90	0.21	1.25	21.61	....	
April, ...	77	839	15.49	1,308	31.20	15.80	....	14.5	2.90	0.10	0.75	13.55	....	One pullet died.
May, ...	78	746	13.65	1,307	30.49	16.84	....	14.5	2.90	0.12	0.50	14.32	....	50% of birds with severe *colds due to wet weather.*
June, ...	78	521	9.15	779	19.46	10.31	....	13.5	2.70	0.06	0.50	8.05	....	
July, ...	73	600	10.53	729	19.43	8.90	....	13.5	2.70	0.06	0.50	6.64	....	5 pullets died during this month.
August, ...	73	626	10.97	800	24.00	13.03	....	13.5	2.70	0.06	0.50	10.77	....	
Sept., ...	73	677	12.27	657	24.08	11.81	....	13.5	2.70	0.06	0.75	9.80	....	
Oct., ...	73	677	13.00	648	29.16	16.16	....	13.5	2.70	0.40	1.50	14.56	....	
Totals, ...	76	8,121	$145.09	10,997	$331.82	$186.73	....	160.5	$21.30	$4.22	$11.75	$160.96	....	

Average profit per bird over feed, ... $2.46
Average egg production per bird, ... 144.7
Average price per egg, ... $.0301
Average receipt of manure per bird, ... $0.155

Average profit per bird over feed and labor, ... $2.12
Average feed consumed per bird, ... 107 lbs.
Average cost of feed per hundred, ... $1.78
Average labor hour per bird, ... 2.2

This is a fair example of the other demonstrations as carried on under this project, none showing a loss when labor was not figured, and only one showing a loss when that item was taken into consideration. This project has been a great help to the localities in which it was conducted, because many neighbors were convinced, after studying records and becoming acquainted with methods, that, with but a little systematic labor, efficient rations, etc., a considerable income could be derived from the farm flock. In all cases reports were made by the coöperators that labor and time were saved, even when the time for records was included, by using definite systems of management. All reported that they had no idea before conducting the project what the cost for feed or labor was for their flocks, nor had they any idea as to the profit or loss made with their poultry. All who took part in the project have again asked for a set of record blanks so that they might keep cost and profit or loss records on at least part, and in some cases on the whole, of their flocks of poultry.

Since major projects 5 and 6 were organized only this summer and are to be conducted during the winter and spring months, no report can be made on them, except that a large number of coöperators are at present conducting these projects.

Summary

The report for all lines of effort in total is as follows: Letters written in answer to inquiries and requests to conduct other work, 3,275; advisory trips to farmers other than those conducting projects, 250; 120 of which were made with county demonstrators. Advice on these trips was given on various subjects, stock, houses, feeding, diseases, laying out poultry plants, incubation, brooding, etc. Eighty-three lectures were given on various poultry subjects of which 33 were illustrated with lantern slides, and 5 with a blackboard and chalk. Ten were given at farmers' institutes, 12 at poultry shows, 7 at county Y. M. C. A. gatherings, 15 to boys at public schools, 5 at farmers' meetings other than institutes and granges, 3 at grange meetings, and 31 to poultry associations. The total attendance at all of the lectures was approximately 6,270, divided as follows:—at institutes 500, at poultry shows 2,400, at Y. M. C. A. meetings 420, at public schools 1,500, at farmers' meetings 150, at granges 60, and at poultry association meetings 1,240. Demonstrations given numbered 42, divided as follows:—caponizing 19, killing and picking 4, candling and grading eggs 4, culling pullets for layers 8, and mating breeding pens 7. The average attendance at the meetings was about 6.

The State Poultry Association, through the system organized by the extension specialist, has to date bought 52 carloads of poultry feed at an approximate total cost of $36,400.00.

During the year 495 major and minor projects were conducted, itemized as follows:—Minor projects No. 2, 303; No. 3, 4; No. 4, 3; No. 5, 20; No. 6, no record kept; No. 8, 50; No. 9, 0; No. 10, 5. Major projects No. 1, 42; No. 2, 2; No. 3, 56; No. 4, 10. Practically all of these projects have been completed, and in all major projects at least three visits were made during the year.

During the year four poultry educational exhibits were held, all of which were extensive and complete. The specialist judged 6 poultry shows in the State. Three circulars were written by the extension specialist this year, namely:—1. Coöperative Buying of Poultry Feeds as Carried on by the New Jersey State Poultry Association; 2. Market Eggs of High Quality, and 3. Green Croops for the Poultry Yard.

REPORT OF THE EXTENSION SPECIALIST IN DAIRY HUSBANDRY

JOHN W. BARTLETT

Extension work in dairy husbandry was begun May 1 of this year. Dairy farming in this State is confined to about 10 counties. Because of the nearness to the best markets the industry should receive careful attention, and aid given to the dairymen.

The work of the past six months has been mainly that of aiding in the organization of cow testing associations, and making monthly visits to those already active. The Bergen-Passaic Association was organized in August and began operations September 1. In Middlesex County about 20 dairymen have pledged themselves toward such an organization, and it is expected the work will start by January. Cumberland County dairymen asked that some time be spent in that part of the State and sufficient interest has been shown to warrant an association there by December 1. It seems probable that in a few months there will be cow testing associations in Warren and Hunterdon Counties.

At the present time there are five very active cow testing associations in this State. Two are located in Sussex County, one in Burlington County, one in Salem, and a fifth is made up of dairymen from Bergen and Passaic Counties combined.

The Sussex County Association was organized in 1913 and at present has a membership of 20, with about 600 cows under test. The Wallkill Valley Association, which is in the upper section of Sussex County, was organized by Mr. Bennetch. It has 16 members, about 450 cows being tested. In Salem County testing was begun in 1914 and at present 22 members are having 600 cows tested each month. The Burlington County dairymen organized in the early spring of 1916 with a membership of 9 farmers, controlling 410 cows.

The Bergen-Passaic Association was the last one organized. Twenty-six farmers are coöperating and records are being kept on about 560 cows.

The results of record keeping have been shown in every association. Several unprofitable or boarder cows have been disposed of. A good many farmers have changed their grain rations and have produced more milk, more economically than before. Calves have been raised from the best cows and in several cases pure-bred animals have successfully completed the advanced registry requirements.

Demonstrations

The use of a home-mixed calf meal as a substitute for milk has been advocated and several dairymen are raising calves very successfully. Cost accounts and the rate of growth have been kept in some cases. This mixture was tried out by Mr. Bennetch in Sussex County where calves were raised to one year of age at a cost of $33.

In several instances where dairymen were too far apart to warrant the organization of a cow testing association, daily milk record sheets have been furnished and the farmers induced to weigh their milk daily. This has proved beneficial in that they were able to feed their herd more intelligently and could easily pick out any unprofitable cows.

Aid was given the state leader of club work in organizing 5 dairy contests. Babcock testing and record keeping were explained at the schools and several milk-testing demonstrations were given.

Activities

A summary of the work for the six months is as follows: Meetings held, 9 (total attendance, 311); farms visited, 327; letters written, 185.

Several visits were made to farms upon request and advice was given upon feeding, changing of rations and dairy barn construction. About 30 balanced rations have been figured for farmers.

REPORT OF THE STATE LEADER IN BOYS' CLUB WORK

WM. H. MCCALLUM

Boys' agricultural contest and club work is a new feature of the extension division work. The country schools, coöperating with the farm demonstrators and the county Y. M. C. A. committees have been conducting clubs and contests in a few of the counties for about ten years. This work has been organized to fit local conditions and differs greatly in each county. While it is the object of the extension division to help in agricultural endeavors and to assist in solving local problems, it is recognized that local conditions determine the best methods of conducting such work in each community. The extension division aims to generalize such methods throughout the State, only in so far, however, as there is no conflict with local conditions.

The county agents have been aided in organizing and supervising clubs, in giving demonstrations, and in other work. The various specialists assisted in demonstration work and in supervising clubs, especially in the unorganized counties. A large number of demonstrations upon phases of farming necessary to certain contests at particular times were given. Sixteen mimeographed sheets of simplified instructions were sent out at the proper seasons. The experiment station circulars and United States Department of Agriculture bulletins formed the basis of instructions and were supplemented by the above-mentioned mimeographed sheets. The record books furnished by the United States Department of Agriculture have also been extensively used in many of the counties. Altogether, the enrollment in boys' agricul-

tural clubs in the State averages about 2,000. This includes those enrolled in and directed by the county Y. M. C. A.'s and the vocational schools. The farm demonstrators and schools were assisted in organizing and directing eleven corn clubs, with an enrollment of 93, two potato clubs, with an enrollment of 35, eight garden clubs, with an enrollment of 99, eight poultry clubs, with an enrollment of 169, one pig club, with an enrollment of 12, one dairy contest, with an enrollment of 25, and three sweet potato clubs, with an enrollment of 30.

Since April, 616 letters have been written, 54 meetings held, with a total approximated attendance of 1,828, and 211 plots visited personally.

During October a swine-judging team of three boys, selected from the members of the pig club in Morris County, represented New Jersey at the National Dairy Show at Springfield, Mass., and won the first prize for judging. The sweepstake award also was won by a member of the team. Six exhibits of dent corn grown by boys from different counties also took prizes at the show.

Prospects for the coming year are much brighter. A number of the unorganized counties are now organized on a year's basis, and are using agricultural contests and clubs in the schools as a means of promoting a better agriculture in the respective counties. Throughout the year the United States Department of Agriculture bulletins and experiment station circulars, as well as the special mimeographed instructions, will be issued to the local leaders for distribution at the proper time. Demonstrations will be given and talks held on the various phases of farming suitable to the particular season. The specialists also will help on these occasions.

Organization into clubs has not been emphasized in many communities. When it is possible to form clubs, satisfactory results are obtained. Meetings are held at which the boy officers preside, reports are made by the members, and demonstrations and lectures given. Communities where there are no boys' clubs have simply school contests, but supervision and instruction is much harder without some form of organization. A few of the thinly settled counties find club organization impossible.

REPORT OF THE EXTENSION SPECIALIST IN HOME ECONOMICS

M. Anna Hauser

The home economics extension work has made progress during the past year. The basis of organization of this work was given in the annual report one year ago. The two main projects, as indicated at that time, are the organization in rural communities of home economics associations for women and canning clubs for girls and boys.

Up to July 1, 1916, the canning club work was carried on as part of the home economics project; on the above date the boys' and girls' canning club work was made a separate project of agricultural extension with Miss Fannie F. Cooper as State leader, and the definite result of this work, therefore, is given in a separate report.

The demands for work were so great that it was necessary to add a third worker, and Miss Emily Leeds was appointed on March 1 temporarily for the summer to assist in both the work of the women's clubs and the girls' clubs of the State.

The widely varied activities that have been characteristic of the home economics work from the very beginning have been continued throughout the past year: first, because of the demands for practical demonstrations and instruction from different persons and organizations throughout the State; and second, in order to continue to popularize the endeavors along this line so that sufficient financial and moral support may eventually be secured to carry on the work on a basis large enough to meet the great demands. When this work was started about two years ago it was looked upon with something like suspicion by a great many people, but popular opinion has been entirely changed and the great value of the science that deals with the problems of the home is now recognized by all classes of people.

The county farm demonstrators, school superintendents, grange leaders and others interested in rural life feel that in order to make their work more efficient and country life more attractive it is not only necessary to aid the farmer to produce larger crops and secure better markets for them, but it is also necessary to give the housewife on the farm a chance to learn something of the science of using the money and products at her command to the best advantage so that the highest development of the family and community life may be secured. It is almost impossible to report the most far-reaching results of this work. When the writer returns to communities where demonstrations have been given and finds women who have canned from 150 to 500 quart jars of vegetables when they had canned no vegetables during the previous years—is told that canned fruits have a much better flavor this year than they had when canned by the old method—finds five or six home-made fireless cookers working in a community; finds scores of farmers who say they have no more tough round steak served in their homes; sees kitchens rearranged to save time and energy in doing housework and new labor-saving devices installed where very crude methods of work were practiced—these represent some of the actual results of home economics extension work.

Home Economics Associations

The demand for organization of women in rural communities for the study of home problems is constantly increasing. However, with the demand for talks and practical demonstrations from the various organized and unorganized groups of women throughout the State constantly increasing, and with the already great demand on the time of the specialists from the home economics associations, it was thought best not to organize any new associations until additional help can be secured.

In counties where there were repeated demands for home economics extension work, in a great many communities home economics committees in connection with the farm demonstration office were appointed to arrange for the demonstrations and to see to advertising the meetings in their respective communities. In two counties through the work of the home

economics associations, the home economics committees and the girls' canning clubs, the home economics work has reached such a stage of development that steps are being taken to place a trained woman in the county to do home economics extension work. These workers in other States are called women county agents and have the same relation to the women of the county that the farm demonstrator bears to the men of the county.

Summary of Activities

The total number of meetings held during the year is 202 and the total number of people addressed is 12,364. There were 75 canning demonstrations, 54 demonstrations along other lines and 73 talks or lectures. Besides meeting 2,200 people through lectures given at 24 farmers' institutes throughout the State, 49 talks or lectures were given at grange meetings, women's clubs, housewives' leagues, parent-teachers' associations, county board of agriculture meetings, schools and meetings of church and community groups. There were 24 demonstrations and talks at meetings of women's club and housewives' leagues, the estimated attendance being 1,176. Thirty-one talks and demonstrations were given in connection with grange programs. The attendance at these meetings was 1,734. One thousand eight hundred and eighty-three people were reached by 13 talks and demonstrations given at parent-teachers' associations. Thirty talks and demonstrations were given for the benefit of home economics associations. Unorganized community groups were served 28 times either by talks or demonstrations. There were 16 meetings in the interests of girls' canning club work. There were 7 talks and demonstrations in schools, 2 talks at country life conferences, 2 demonstrations at meetings of civic associations, 1 demonstration at a Y. W. C. A. meeting, 2 demonstrations for church groups, 1 demonstration at a teachers' meeting and 5 talks and demonstrations at county board of agriculture meetings. An exhibit of canned fruits and vegetables was shown at the Inter-State Fair and also at 3 county fairs; in each case canning demonstrations were given to show the method by which the products were canned. Three times service was given by judging domestic science and domestic art exhibits.

Another feature of the home economics work was the writing of newspaper articles from time to time and the preparation of four pamphlets outlining the principles and instructions given at the demonstrations. Work is under way for the preparation of a number of bulletins in this department during the coming year. A great many people were served by having questions answered through correspondence. The total number of letters written was 1,020 and the number of circulars and circular letters sent out was 1,162.

There is a decided increase in the demands for home economics work at farmers' institutes, women's clubs, housewives' leagues, parent-teacher associations meetings, etc. The demand for organization for women in rural communities where there is no organization is constantly increasing; repeated requests have come from school superintendents for help in getting home economics work started in the schools. The series of demonstrations and lectures for organized groups is a popular request that could not be

filled during the past year. Steps are being taken to add two new workers to the staff besides the women county agents previously mentioned. As the new appointments are made, the work will be divided so that each woman will be in charge of some one phase of the home economics work and be a specialist in her own particular line.

REPORT OF THE STATE LEADER IN GIRLS' CLUB WORK

FANNIE F. COOPER

The girls' club work is carried on in coöperation with the county farm demonstration bureaus, public schools, granges, Y. W. C. A.'s and other organizations which may exist in a community. The aim of the club work is to interest the women and girls of the State in matters pertaining to the farm and home by bringing them in touch through demonstration work conducted by the State leaders and the club members themselves with the best known methods in home economics and agriculture.

The girls' club work as carried on during the past year was practically a continuation of the work of the previous year. The work consisted mainly of demonstrations in canning fruits and vegetables, home gardening, cooking vegetables, cooking milk and eggs, bread making, sewing and crocheting. Considerable time was given to the organization of canning clubs, mother-daughter clubs, gardening and canning clubs, to personal visits to garden plats, placing exhibits, judging domestic art and domestic science exhibits, training demonstration teams, directing canning contests at county board of agriculture meetings, at county fairs and at the Eastern States Exposition at Springfield, Mass.; answering, by letter, inquiries on home economics subjects, on gardening and on the organization of home economics clubs and preparing follow-up instructions for club members.

During the past year in New Jersey there were 12 counties doing organized club work, with a total enrollment of 991 members; this makes an increase over last year of 5 counties and 372 members. These club members are enrolled in 48 clubs, with a local leader for each club. The State leader secured the help of volunteer local leaders in each of the forty-eight organized club groups during the year who assumed leadership of these groups and helped in local follow-up work, such as holding club meetings, visiting club plats and keeping up active interest during the year. The help of one paid local leader was also secured who held weekly meetings with club members and who visited each garden plat three times during the growing season. Through the coöperation of the County Farm Demonstration Bureau of Monmouth County, a woman worker was employed during the past summer who supervised the work of the canning clubs in that county during the canning season.

The girls' club work has been more concentrated in several of the counties than in others, and steps have been taken to secure the help of trained workers throughout the year. The requests from these counties for the organization of girls' canning clubs and mother-daughter clubs have been more numerous than could be met by the present workers in the field.

These club groups may not be safely organized without making provision for careful supervision for the follow-up work.

The club work has been shown to be the most effective way to interest women and girls in the home and to bring mother and daughter together to study the problems of home making; to arouse a better community spirit; *to increase interest in school work; to bring the school into the home and* the home into the school; to teach thrift and to encourage organized effort and team work; to promote better health; to eliminate waste and save surplus; to encourage greater production; to teach labor and time saving in the home; to arouse greater interest in efficient and economic home management; to dignify home work; to reduce the high cost of living; to teach the "balanced ration" doctrine; to develop earning power; to encourage ownership and to train for efficiency in home making.

Lectures

During the year 12 lectures were given at different meetings throughout the State. Ten of these lectures were on the girls' club work and two on home gardening, five being given at farmers' institutes conducted by the State Board of Agriculture. The approximate attendance of these meetings was 600. There were five given to home and school associations and the school children, with an attendance of 400. Two were given at teachers' institutes, with an attendance of 250. The total attendance at the lectures given was 1,250.

Demonstrations

Demonstrations were given in canning fruits and vegetables in home gardening, cooking milk and eggs, cooking vegetables, bread making, crocheting and sewing. One hundred seventy-five demonstrations were given with a total attendance of 5,280 people. One hundred sixty of these demonstrations were given to previously organized groups. Each demonstration consists of a lecture and actually showing the process of canning or of that phase of home economics work which is being considered. The members of the club groups actually do the work of canning and gardening under the supervision of the State leader. It is felt that more good is derived from these demonstrations than from those given by an individual. The girls learn a great deal more by doing the work themselves than they do by *simply seeing it* done. *During the past year 9 demonstration teams, with 3* girls in each team, were trained for demonstration work in canning fruits and vegetables; in laying out a garden plat; and in the construction of a home-made fireless cooker. Two of these teams gave a demonstration at the National Educational Association extension meeting in New York, two at the Bergen County Fair, two at the Monmouth County automobile tour and three at the Eastern States Exposition at Springfield, Mass. These demonstrations created a great deal of interest, and were very favorably received by those who attended the meetings.

Correspondence

During the past year 1,193 letters were answered on different phases of home economics work, home gardening and the organization of girls' clubs and mother-daughter clubs; 2,254 circular letters were written giving the club members timely instructions for carrying on their gardening and canning work. In many cases these instructions were not only beneficial to the club members receiving them, but were passed on to neighbors and friends. They, in turn, passed them on to their acquaintances, the result being the best kind of extension work.

Educational Exhibits

The girls' clubs from 5 counties sent an exhibit of about 400 quarts of fruits and vegetables to the Inter-State Fair; 6 clubs in Monmouth County exhibited 423 quarts of fruits and vegetables at the county fair; and 3 clubs in Bergen County exhibited 100 quarts of fruits and vegetables at their county fair. The canning club girls of New Jersey also sent an exhibit of 524 quarts of fruits and vegetables to Springfield, Mass., to be exhibited at the Eastern States Exposition. The exhibits were most satisfactory, showing very clearly the training which the girls received in the best methods of canning. Three domestic science and domestic art exhibits were judged.

Summary of Activities

The total number of meetings held during the year is 187 and the total number of people reached, 6,530. There were 175 demonstrations given—of these 70 were canning demonstrations, 36 sewing and crocheting demonstrations, 41 demonstrations in cooking along other lines and 24 gardening demonstrations—10 lectures were given on club work and two on home gardening; 80 club plats were visited and 1,193 letters and 2,254 circulars written. Three domestic science and domestic art exhibits were judged.

REPORT OF THE DEPARTMENT OF AGRONOMY

Department of Agronomy

FRANK APP, B.Sc., *Agronomist*

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Report of the Department of Agronomy

Frank App

The investigational work of the Agronomy Department has been along two distinct lines. The first line of work incorporates farm crops while the second line of work embodies farm management.

I

FARM CROPS

The work on farm crops is much the same as that reported for the year 1915.

Corn

The more common varieties of corn were grown in duplicate plots of 1/46 acres each. A heavy alfalfa sod was turned under for the corn. Acid phosphate was added at the rate of 250 pounds per acre and the corn was planted May 20 to 23, 1916. It is yet too early to obtain the air-dry weights, so the yields cannot be reported here.

Community Tests

Since 1914, varieties of corn have been collected by the extension specialist in agronomy from different localities in the State and grown on some central farm in the neighborhood where they were collected. The usual method followed was to collect samples of corn grown by the farmer, from approximately 20 adjacent or nearly adjacent farms. They were then taken to some central farm in the selected region and grown in plots of two rows for each strain and adjacent to each other. They were given like treatment and, when harvested, the different strains were weighed and their yields calculated. While results should be interpreted rather broadly, yet they serve to answer some very pertinent questions.

Data such as these are highly suggestive. They show a striking lack of properly standardized and recognized varieties and types of corn for the State. The average of 423 tests shows an average yield of 62.4 bushels per acre. The lowest average yields from 22 different localities where these tests were made is 46.2 bushels, while the highest yield from these 22 different

TABLE I

Yields of Corn Grown in Community Test Plots Throughout New Jersey as for 1914, 1915 and 1916, Inclusive

CO-OPERATOR.	Rank of Farm.	Highest Yield.	Yield of Corn Where Farmers' Test Was Made.	Lowest Yield.	Average Yield.	No. of Varieties Tested.	County.	Place.
1914.								
R. G. Baynes, ...	3	94.5	90.3	69.0	83.0	20	Salem, ...	Woodstown.
Herman Crowshaw,	9	85.3	78.9	69.9	78.3	21	Burlington, ..	Wrightstown.
J. W. Allen, ...	11	52.5	41.7	27.1	41.6	20	Hunterdon, ...	Sergeantsville.
John Garwood, ...	2	07.1	87.5	60.0	78.0	19	Camden, ...	Ashland.
1915.								
Frank Danser, ...	2	63.5	60.0	31.0	50.2	23	Mercer, ...	Cranbury.
John M. Evans, ..	14	51.9	40.5	30.6	44.0	20	Middlesex, ...	New Market.
Fred'k Demarest,.	3	71.6	63.8	21.9	44.0	20	Bergen, ...	Westwood.
C. S. Cresse, ...	6	88.2	60.1	38.1	57.6	28	Cape May, ...	Mayville.
Daniel Moore, ...	9	71.0	65.0	40.0	64.0	15	Cumberland, ..	Bridgeton.
C. R. Hires, ...	3	81.5	77.5	57.0	69.0	22	Salem, ...	Salem.
Asa Moore, ...	9	74.0	60.0	42.0	58.5	20	Gloucester, ...	Mullin Hill.
John Tine, ...	13	77.0	48.0	34.0	51.0	23	Hunterdon, ...	Lebanon.
Owen Oberly, ...	1	106.0	106.0	55.0	76.0	16	Warren, ...	Stewartsville.
Chas. Cornish, ...	5	73.0	64.0	34.5	00.0	17	*Morris, ...*	*Stirling.*
1916.								
E. J. Sexsmith, ..	4	74.8	69.7	53.3	64.5	11	Monmouth, ...	Como.
English Bros., ...	16	49.5	41.0	96.5	42.7	21	Atlantic, ...	
John Van Aken, ..	4	91.5	82.9	50.0	73.5	12	Middlesex, ...	
J. P. Ridgway, ..	9	73.3	60.0	48.7	63.0	16	Salem, ...	Hancock's Bridge.
J. Herbert Brown,	15	74.0	62.5	53.0	66.0	18	Gloucester, ...	Swedesboro.
L. C. Mackeys, ...	8	110.0	95.0	74.0	91.0	18	Warren, ...	Belvidere.
J. S. Cray, ...	3	68.8	67.5	33.3	61.5	27	Hunterdon, ...	Lambertville.
W. R. Stefford, ..	9	78.4	68.3	48.3	65.2	18	Camden, ...	Haddonfield.
Average, ...	....	77.5	67.7	46.2	62.4	423		

localities is 77.5 bushels, or a difference between the highest and the lowest of 31.3 bushels, or 68 per cent. The greatest difference was obtained in 1915 in Hunterdon County. Here the highest yield was 77 bushels and the lowest 34 bushels, a difference of 43 bushels, or 226 per cent. By the mere elimination of only the varieties below the average, the acre production of these

farms as a whole would be increased 7½ bushels, while eliminating all but the very best varieties, the acre production would be increased on these farms by 15 bushels. This would not call for any additional labor such as that required for the production of pedigreed corn. It is a convincing argument for fewer and better varieties of corn for New Jersey. Should farmers discard their mongrel varieties and grow only the best, such action would be the one most needed improvements for our corn crop. It is only through such community tests that this need will be recognized by the farmers. Probably the most satisfactory way to bring about this improvement is through community tests followed by a more systematic and careful method of isolating the superior varieties now grown in the different localities. Many regions and at least every county should have two varieties. One of these should be adapted to less fertile soils, while the other to more typical corn soils in good tilth. However, at the present time nearly every farmer has a different strain or variety of corn. Should he attempt to keep it entirely pure he will have trouble with crossing from his neighbor's fields. This makes it extremely difficult for one man alone to improve his crop and keep a superior strain.

This work, then, should be done by the community as a unit. It is essential that improved strains or superior strains be produced in the region where they are to be grown. Corn, when taken a distance from its former habitat, will not produce its best until it becomes acclimated. This usually requires two or more years. Therefore, improved corn brought from another State or region would need to be acclimated before it could be compared with the native corn. This was well substantiated by improved varieties introduced by the extension specialist in agronomy and grown beside native corn. In most instances they did not produce as well as native varieties.

Oats, Barley and Spring Wheat

The oats varieties were seeded May 2, 1916. Each variety was grown on a plot 1/30 acre in size. They followed corn from the preceding year in the rotation. Acid phosphate was added at the rate of 350 pounds per acre. A rank growth of straw was obtained but the yield of grain proved to be light. This was probably due to the hot weather which prevailed during the ripening period. Though the panicles appeared well developed, when rubbed out the kernels were very light. In many cases no kernel was developed within the flowering glume and palea. In other cases it appeared only partially developed. Table II con-

tains a list of varieties as they were grown in the field with their yield.

While there is a difference in the yield obtained from these oats there is no variety which stands out as exceptional. With such an adverse season the grain yield cannot be considered as typical. The straw yields are more representative. These ranged from 2,017 pounds for Early Champion to 3,211 pounds for Joanette. Some varieties are far better straw producers than

Table II

Yield of Oats, Spring Wheat and Barley Grown in the Variety Test for 1916

Plot.	VARIETY.	Total Wt. from Plot, Lbs.	Wt. of Bundles Kept, Lbs.	Wt. from Bundles, Lbs.		Yield of Grain Per Acre, Bu.		Yield of Straw Per Acre, Lbs.	
				Of Grain.	Of Straw.	Actual.	Corrected.	Actual.	Corrected.
1	Check.	157.	9 + 6	2.2	9.0	21.5	......	3,140	......
2	Canada Cluster,	172.	10 + 8	2.6	10.5	23.3	20.9	3,000	2,430
3	Early Champion,	129.	5 + 6	1.9	10.0	22.9	23.9	2,348	2,017
4	60-Day,	104.	5 + 4	1.8	7.0	19.5	18.9	2,430	2,190
5	Kherson,	110.	8 + 6	2.8	9.0	20.6	19.9	2,121	2,088
6	Check.	127.	11 + 10	3.0	12.5	17.0	......	2,268	......
7	Sw. Select,	130.	6½ + 6	2.2	8.2	21.4	23.7	2,415	2,520
8	Big 4,	136.	10 –	1.5	7.0	19.1	22.0	2,856	2,937
9	Worthy,	133.	8 + 6	2.8	8.5	24.9	30.0	2,400	2,436
10	4th of July,	132.	7 + 6	2.2	......	20.5	25.7	......	......
11	Check,	122.	11 + 7	2.2	......	13.9	......	2,430	......
12	Czar of Russia,	143.	8 –	1.2	5.0	20.1	22.9	2,680	2,100
13	Long's White Tartar,	148.5	10.5 + 13	3.2	12.0	18.9	19.1	2,370	2,478
14	American Banner,	134.	10	1.5	7.5	18.8	17.0	3,000	3,211
15	Silver Mine,	142.5	21.5	3.0	14.5	18.6	15.3	2,880	3,125
16	Check.	153.	11 + 15	4.4	12.0	24.0	......	2,118	......
17	Bumper Crop,	223.5	12 + 14	3.7	10.0	29.8	22.7	2,655	2,931
18	Shadeland Climax,	155.	10 + 10.5	2.9	11.0	20.5	16.5	2,190	2,446
19	Improved White Russian,	221.	10 + 12	1.7	9.5	16.0	13.4	2,862	3,004
20	Clydesdale,	131.5	8 + 6	2.6	10.5	22.9	19.9	2,958	3,031
21	Check,	143.	9 + 9	2.7	10.0	20.1	......	2,400	......
22	Welcome,	154.	11 + 10	2.7	12.0	18.5	17.8	2,640	2,630
23	Joanette,	196.	8 + 11	1.9	10.5	18.3	18.6	3,240	3,220
24	Black Tartarian,	192.	11 + 13	3.3	10.0	27.2	29.6	2,400	2,370
25	Regenerated Swedish Select,	133.	9	1.4	6.0	19.4	22.6	2,661	2,900
26	Check,	127.	7 + 11	2.2	......	14.5	......	2,350	......
27	New Danish White,	124.	11 + 10.5	2.5	12.0	13.5	16.7	2,076	2,162
28	Barley Oder Brucker,	113.	9.5 + 10	4.5	10.0	17.4	20.9	1,734	2,027
29	Maudescheurt,	113.	11 + 10	5.5	10.5	18.5	22.0	1,695	1,849
30	Spring Wheat,	58.	9	1.6	6.0	9.6	11.1	946	1,048
31	Check,	123.	12 + 9	2.9	12.0	15.9	......	2,109	......

others. These should be given careful consideration when selecting a variety for oats and peas to be grown for forage. Among the largest straw-producing varieties are American Banner, Silver Mine, Clydesdale, Improved White Russian, Bumper Crop and Big Four. Taken as a class the early varieties produce less straw than varieties maturing later. This is substantiated by the straw yield of 60-Day, Kherson and Early Champion, whose yields are approximately a ton of straw per acre. These varie-

ties matured fully one week earlier than the others. But 85 days were needed to mature them while 90 to 100 days were required to mature the other varieties.

The barley made comparatively a more satisfactory yield than the oats, but it was not sufficient to consider it satisfactory. Marquis Spring Wheat was low in yield, and, like the barley and oats, was unsatisfactory.

Table III

Yield of Wheat Grown in Variety Test for 1916

Plot.	VARIETY.	Total Wt. from Plot. Lbs.	Wt. of Bundle Kept, Lbs.	Wt. of Grain from Bundle, Lbs.	Wt. of Straw from Bundle, Lbs.	Yield Per Acre.		Corrected Yield Per Acre.	
						Grain, Bu.	Straw, Lbs.	Grain, Bu.	Straw, Lbs.
1	Check,	220	12.0	3.0	9.0	20.7	5,346	......	......
2	Reliable,	219	21.0	5.5	15.5	30.1	5,056	28.6	4,545
3	Out Wonder,	235	20.0	4.8	15.2	30.7	5,710	27.2	4,993
4	Dawson Golden Chaff,	210	21.0	5.9	15.1	32.0	4,915	29.2	4,183
5	Deitz's Longbury Red,	205	17.0	4.2	12.8	27.6	4,908	24.6	4,119
6	Check,	250	15.0	3.6	11.4	32.9	6,119	......	......
7	Fultz,	200	15.0	3.2	11.4	23.4	4,014	20.9	4,169
8	Turkish Amber,	199	9.0	1.7	7.3	18.7	4,824	17.0	4,308
9	Poole,	206	9.0	2.6	6.4	32.7	4,708	30.3	4,441
10	Redwave,	214	10.0	2.8	7.2	32.2	4,830	30.4	4.820
11	Check,	202	9.0	2.5	6.5	29.9	4,664	......	......
12	Fulcaster,	190	7.0	2.75	4.25	40.5	3,645	39.4	3,829
13	China,	229	11.5	3.3	8.2	35.7	5,355	35.7	5,671
14	St. Louis Grand Prize,	195	13.5	2.8	10.7	21.9	4,993	22.4	5,150
15	Jones' Longberry, No. 1,	215	12.5	2.5	10.0	22.6	5,424	23.4	5,547
16	Check,	206	9.0	2.2	6.8	27.1	4,878	......	......
17	Rudy	195	15.5	3.1	12.4	21.1	5,064	22.5	5,156
18	Fultz Mediterranean,	188	14.0	4.6	9.4	33.4	4.008	35.8	4,009
19	Marvelous,	207	8.5	2.9	5.6	38.2	4,354	41.2	4,474
20	Miracle,	205	13.5	4.3	9.2	35.8	4,510	38.7	4,633
21	Check,	195	13.0	3.25	9.75	26.5	4,770	......	......
22	Price's Wonder,	167	14.0	2.9	11.1	18.7	4,263	20.1	4,567
23	Pennsylvania Selection 25-08,	162	13.5	4.4	9.1	28.5	3,420	30.2	3,828
24	Rochester Red,	187	15.5	4.3	11.2	28.4	4,430	29.7	5,163
25	Nigger,	187	12.0	3.8	8.2	32.1	4.044	33.1	4,917
26	Check,	168	15.0	4.6	10.4	28.2	3,891	......	......
27	Valley,	216	13.0	3.0	9.4	32.1	5,007	33.0	6,036
28	Currell's Prolific,	190	15.5	5.1	10.4	34.1	4,092	35.3	4,691
29	Mealy,	163	10.0	2.3	7.7	20.3	4,019	21.1	4,372
30	Pennsylvania Bluestem,	182	12.0	2.2	9.8	18.5	4,844	19.4	5,206
31	Check,	165	13.0	2.4	10.6	27.3	4,945	......	......
32	Leap's Prolific,	170	12.0	3.4	8.6	26.1	......	......	......
33	Ohio 5309,	113	8.0	1.9	6.1	25.3	......	......	......
34	Ohio 6100,	115	10.0	2.0	8.0	20.7	......	......	......
35	Ohio 6545,	93	12.0	1.2	10.8	8.1	......	......	......
36	Check,	70	3.0	1.6	7.4	11.5	......	......	......
37	Ohio 6414,	73	10.0	2.3	7.7	15.0	......	......	......
38	Gypsy,	78	13.0	2.7	10.3	14.9	......	......	......
39	Pennsylvania Selection 13-09,	78	17.0	4.0	13.0	17.0	......	......	......
40	Pennsylvania Selection 64-11,	56	13.0	2.1	10.9	10.3	......	......	......
41	Check,	51	12.0	1.4	10.6	5.4	......	......	......

Wheat

Although New Jersey is located close to the best markets of the country, so as to make the culture of intensive crops important, still there is great demand for small grains such as wheat, rye and oats to complete the rotation and fill the need of a small grain crop. This need will probably continue for many years. It is important that we know what varieties of wheat are best adapted to our State if we wish to make the crop most profitable. Table III gives a list of varieties grown at the Station during the past year, 1916, with their comparative acre yields.

The best yielding varieties this year are Marvelous, Fulcaster, Miracle, Fultz Mediterranean and China. The end of the field was poorly drained and beginning with Leap's Prolific, Plots 32 to 41 were injured. These yields, therefore, are not representative. Before these varieties can be considered superior for New Jersey it will be necessary to repeat these trials for a number of years to make them conclusive. However, it serves to illustrate a great difference in yield and proportion of straw. Fulcaster is a bearded, red, semi-hard winter wheat which is known nearly all over the Eastern States as a good producer. Miracle and Marvelous have been commanding much attention recently as good yielders, while China is an old variety of good repute.

Forage Crops

Of the different forage crops tested those of most interest at present are alfalfa and Sudan grass. The latter appears to be a crop suited to the purpose and requirements of millet. Sudan grass and millet were seeded for comparison.

YIELD OF SUDAN GRASS AND GERMAN MILLET PER ACRE

Crop	*Date of Seeding*	*Date of Harvesting*	*Yield: Green Weight Per Acre*
German Millet, ...	June 13	August 26	4.8 tons
Sudan Grass, ...	June 10	September 24	5.9 "

But one cutting was obtained from each forage crop. An analysis of Sudan grass is given below:

	No. I Seeded June 6	*No. II Seeded June 13*
Protein, ...	3.03	4.06
Fiber, ...	31.98	32.69
Fat, ...	1.91	1.95
Ash, ...	4.73	5.42
Nitrogen—free extract, ...	58.35	55.88

It is evident that it is not high in nutritive values, and, consequently, its feeding value does not equal that of legumes. If judged from the analysis, its feeding value is low when compared with millet, timothy or red top. However, for the soils of New Jersey from New Brunswick south, Sudan grass should be considered as an emergency hay crop which probably will out-yield millet. In favorable seasons two crops should be obtained or one good hay crop and a pasture crop.

ALFALFA

D. A. COLEMAN, RESEARCH FELLOW, RUTGERS COLLEGE

The experimentation with alfalfa carried out by the Department of Agronomy during the past year was in the nature of a study of the relative values of the methods of seeding the crop for the production of forage. The points taken up were: (1) yield, (2) economy of seeding, (3) duration of stand, (4) freezing out and heaving, (5) cultivation.

For this purpose 6 acres of heavy clay loam soil, which had previously been in oats and peas, were assigned to this department. The six acres were subdivided into three 2-acre plots and the alfalfa seeded, (1) in a mixture with timothy, (2) in pure stand and (3) in rows 36 inches apart. Henceforth these plots will be designated as Plot A, Plot B and Plot C.

The soil was acid in reaction, and for the purpose of changing the acidity pulverized oyster-shell lime was applied at the rate of 2 tons per acre. In addition, each plot received 500 pounds per acre of a fertilizer mixture composed of 300 pounds of acid phosphate, 100 pounds of tankage and 100 pounds of rock salt. It will be seen that in the place usually assigned to potash carriers in fertilizer mixtures salt has been substituted, with the hope that this chemical would make available some of the soil potash.

Soil inoculation was accomplished by means of fresh soil at the rate of 500 pounds per acre.

The cost of the lime, fertilizer and seed is given in Table IV in connection with the labor cost for the laying down of the various seed-beds.

In Plot A the seed mixture was 11 pounds of alfalfa and 9 pounds of timothy per acre, in Plot B, 21 pounds of alfalfa per acre, and in Plot C, 6½ pounds of alfalfa in rows 36 inches apart. All plots were seeded August 18, 1915.

Table IV

Labor of Seeding to Alfalfa When Using Different Methods

	PLOT A.		PLOT B.		PLOT C.	
	Man Hours.	Horse Hours.	Man Hours.	Horse Hours.	Man Hours.	Horse Hours.
Plowing, ...	18.00	48.00	18.00	48.00	18.00	48.00
Applying Lime, ...	8.60	9.60	8.60	9.60	8.60	9.60
Applying Fertilizer, ..	5.00	6.00	5.00	6.00	5.00	2.60
Removing Stones, ...	1.30	0.60	1.30	.60	1.30	6.00
Rolling, ...	1.60	3.30	1.60	3.30	1.60	.60
Seeding, ...	12.00	24.00	6.00	12.00	6.00	33.00
Inoculation, ...	4.00	2.60	4.00	2.60	4.00	2.60
Total Labor, ...	50.50	94.10	44.50	82.10	44.50	82.10

It will be seen that Plot A required more labor than the other two plots, due to the double seeding with alfalfa and timothy. The expense incurred in laying down the various plots is recorded in Table V.

Plot C was started at the lowest cost per acre, $19.15, whereas Plot B cost $21.56 per acre, and Plot A, $21.98.

Observations taken during the fall showed germination to be good. In order to ascertain the influence of the methods of seeding upon freezing of the alfalfa seedlings, plats of an area of one square foot were staked out in Plots A and B, and the number of plants within this area accurately counted. Counts were made on October 8, 1915, by Mr. W. S. Porte, 2 months after germination. In the rowed areas plats one linear foot in size were also staked off and counted. The areas were again counted in the spring of 1916 and the results are given in Table VI.

In Plot A the counts were about the same as those recorded in the fall of 1915. In one or two cases there is a tendency toward a loss, but this is not large, and in general one could not say that timothy created a condition favorable for the freezing out of the alfalfa.

An observation of the counts in Plots B and C show us some astonishing things. Rather than any indication at freezing out we have an actual increase in the number of seedlings present. In casting about for an explanation of this two sources of error appear: (1) the personal error between two analysts and (2) the condition of the seed. The first may be eliminated at once

Table V

Cost of Seeding to *Alfalfa* When Using Different Methods

	PLOT A.		PLOT B.		PLOT C.	
Labor,	50.5 m.h. @ 20c., 94.1 h.h. @ 15c.,	$10.10 14.11	44.5 m.h. @ 20c., 82.1 h.h. @ 15c.	$8.90 12.31	44.5 m.h. @ 20c., 82.1 h.h. @ 15c.,	$8.90 12.31
Fertilizer,	1,000 lbs. @ $17.72 per T.,	8.86	1,000 lbs. @ $17.72 per T.	8.86	1,000 lbs. @ $17.72 per T.,	8.86
Lime,	4,000 lbs. @ $2.75 per T.,	5.50	4,000 lbs. @ $2.75 per T.,	5.50	4,000 lbs. @ $2.75 per T.,	5.50
Seed,	Alfalfa, 22 lbs. @ 18c., Timothy, 18 lbs. @ .08c.,	3.96 1.44	Alfalfa, 42 lbs. @ 18c.,	7.56	Alfalfa, 6½ lbs. @ 18c.	2.73
Total,		$43.97		$43.13		$38.30
Per Acre,		$21.98		$21.56		$19.15

as the differences are too great for any personal equation to enter in. Laboratory tests on the germination of the seed showed 85 per cent. viable seed. It is thought that the hard seeds may have had a chance to germinate in the early spring and were counted as if no new seedlings had appeared. In reality, new seedlings had sprung up since the first counting.

Table VI

Influence of Method of Seeding Upon the Freezing Out of Alfalfa

SEEDINGS PER SQUARE FOOT					
PLOT A.		PLOT B.		PLOT C.	
Oct. 8, 1915	May 10, 1916	Oct. 8, 1915	May 10, 1916	Oct. 8, 1915	May 10, 1916
32	26	82	75	65	36
31	32	50	67	28	32
26	26	40	48	20	25
35	35	52	73	17	29
25	25	75	72	35	65
50	59	70	117	64	94
33	34	55	65	66	..
38	40	61	..	43	66

It would seem, then, that extreme care should be taken to have seeds of an extremely high percentage of germination for the successful carrying out of a test such as this.

The first cutting was made on June 21, 1916. Previous to this it had rained severely for nearly a week and the plots were badly lodged. This was very noticeable on the timothy-alfalfa section. In addition, the crop was a week beyond the proper time of maximum alfalfa yields.

The yields at the first cutting were:

Plot A—6,700 lbs.
" B—5,900 "
" C—1,920 "

Due to the lodging, cutting was difficult and noticeable amounts were left on Plots A and C. Plot B was cut fairly clean. It was estimated that on Plot A 5 per cent was not cut, and on Plot C 10 per cent. In order to determine the ratio of timothy to alfalfa in Plot A, small samples of from 1 to 2 pounds in weight were taken immediately after cutting and the ratio of the green weight of alfalfa to timothy determined. The data are shown in Table VII.

Omitting samples 3 to 5, inclusive, which were taken from an unlimed area of the field, the average ratio in green weight is 1 of the timothy to 1.26 parts of alfalfa. In order to get a more even comparison with the other plots, however, these samples

Table VII

Proportion of Alfalfa to Timothy in Plot A, Seeded to Alfalfa and Timothy

Sample No.	Total Green Wt.	Wt. of Timothy.	Wt. of Alfalfa.	Ratio T : A.
1	912 gm.	512 gm.	400 gm.	1 : 0.92
2	895 "	465 "	430 "	1 : 0.94
3	515 "	462 "	53 "	1 : 0.11
4	620 "	525 "	95 "	1 : 0.18
5	590 "	453 "	137 "	1 : 0.30
6	905 "	532 "	373 "	1 : 0.70
7	819 "	463 "	346 "	1 : 0.74
8	717 "	217 "	500 "	1 : 2:30
9	895 "	255 "	640 "	1 : 2:50
10	755 "	350 "	400 "	1 : 1.10
11	670 "	322 "	248 "	1 : 0.77
12	740 "	320 "	420 "	1 : 1.08
13	995 "	567 "	320 "	1 : 0.56
14	835 "	328 "	507 "	1 : 1.50
15	430 "	155 "	275 "	1 : 1.80

were cured, as nearly as possible under field conditions, and the weight and ratio again determined. These data are given in Table VIII.

Table VIII

Proportion of Timothy to Alfalfa Based Upon Barn-Cured Hay for Plot A, Seeded to Timothy and Alfalfa

Sample.	Weight of Timothy.	Weight of Alfalfa.	Ratio T : A.
1	207	142	1 : 0.68
2	182	158	1 : 0.86
3	208	25	1 : 0.12
4	223	30	1 : 0.13
5	215	60	1 : 0.26
6	227	115	1 : 0.50
7	174	147	1 : 0.74
8	72	108	1 : 1.50
9	110	210	1 : 1.90
10	135	135	1 : 1.00
11	110	98	1 : 0.89
12	120	155	1 : 1.29
13	270	165	1 : 0.69
14	110	155	1 : 1.40
15	50	77	1 : 1.54

Again omitting Samples 3, 4 and 5, the general average based upon the dry weight is 1 part of timothy to 1.08 parts of alfalfa, the alfalfa losing more weight and narrowing the ratio in favor

of the timothy. Parenthetically, it may be pointed out that in the samples from the unlimed area of the field, 3, 4 and 5, the raito of alfalfa to timothy was 0.18 to 1.

Calculating the amount of alfalfa harvested on the acre basis, both from the standpoint of total seed supplied and from a single pound of seed, the following results appear:

Plot	A—(11 lbs. of seed)	1,809	lbs.	per acre
"	B—(21 " " ")	2,850	"	"
"	C—(6½ " " ")	960	"	"
"	A—(per lb. of seed)	164	"	"
"	B—(" " " ")	135	"	"
"	C—(" " " ")	147	"	"

The most interesting point about the data is the fact that Plot A yielded proportionally more alfalfa per acre from the amount of seed supplied, 11 pounds, than Plot B with 21 pounds, despite the fact that plot A had a crop of timothy to compete with for plant-food, etc.

Plot C, on the other hand, made a very poor showing, although appearances would indicate a much larger crop.

The difficulty encountered in cutting Plot C is worthy of note. This plot was cultivated early in the spring. Because of this treatment a pronounced hilling effect was produced. On bringing the mowing machine upon the plot the wheels rested in the furrows made by the cultivator. This, of course, lowered the cutter bar to a considerable degree. Thus when the machine was in operation the cutter bar became clogged with soil, dulling the knife and making it necessary to stop the team many times. Moreover, the alfalfa in the rows grew in a procumbent condition and only certain portions of the crop were cut. As was previously stated, 10 per cent was an estimate of the unharvested crop.

The second cutting was made on August 8. This also was a week in late for maximum yields. An examination of the timothy-alfalfa section showed no aftermath of timothy. A pure stand of alfalfa was present. The yields were as follows: Plot A, 5,080 pounds; Plot B, 4,300 pounds, and Plot C, 1,500 pounds. Calculated to the acre basis we have:

Plot	A—2,540	pounds	per acre
"	B—2,150	"	" "
"	C— 750	"	" "

Unfortunately, labor conditions were such that Plot C was not cultivated after May 11, 1916. Consequently, a rank growth of foxtail sprung up, practically eliminating this plot as any value for comparison with Plots A and B.

It is interesting to note that the yield from Plot A was higher at the end of the second cutting than that of Plot B. This is quite remarkable when it is considered that Plot A has only one-half the amount of alfalfa seed as Plot B. The question arises whether the seeding in Plot B has not been economical. One pound of alfalfa seed contains approximately 220,000 seeds. If evenly sown on an acre this would average about 5 seeds per square foot. It will be seen by consulting Table VI that the number of seedlings per square foot on Plot B was some 2 to 3 times as great as on Plot A. It is also well known that crowded conditions do not allow of the best development of the individual and it would seem that the number of plants per square foot in Plot B was greatly in excess of what was really necessary. In the West fair stands of alfalfa have been grown on 7 pounds of seed per acre. At Letherbridge, Alberta, alfalfa was sown at the rate of 5, 10, 15, 20, 25 and 30 pounds per acre, and the average yields for three years were 10,273; 11,332; 14,426; 11,220; 10,875; and 11,394 pounds per acre. It would seem then, that provided a good stand is secured, a low rate of seeding is just as satisfactory as a high rate. Of course, alfalfa seedlings are poorly adapted to cope with ordinary weeds because the initial growth is largely centered in root production. One would then have to take into account fertility, the probable freedom of the seed-bed from weeds, moisture supply, etc., in deciding just what rate of seeding would be the most desirable for certain conditions.

It is still too early to say whether the timothy will rapidly oust the alfalfa in Plot A. At the present writing the ratio stands 1 to 1. Just to what extent a heavier seeding of timothy would have upon the eventual elimination of the alfalfa in Plot A is a matter of speculation.

We must not leave the discussion of Plot A without referring to the growth of timothy and alfalfa in combination. The practice of growing timothy in combination with alfalfa is increasing. This is a commendable procedure for two reasons. First, it permits the cutting of more than one crop of forage; and, second, alfalfa as ordinarily cut is ready about two weeks before timothy. It is a plant with a high protein ratio ranging from 1:30 to 1:33. In other words, it contains relatively more protein than is necessary for the feeding; for example, of a dairy cow. On the other hand, timothy has a wide nutritive ratio, 1:11. Thus a mixture of the two makes a more balanced ration, eliminating in a great measure the purchase of expensive concentrates to reinforce the forage crops generally used.

In Plot A just such a combination is at hand and the excellent results obtained seem to indicate that much good can be realized by growing these two forage crops together.

The yield of alfalfa in rows has been a disappointment. Other stations have reported excellent results with this method of culture. It would seem that the space between the rows could be easily narrowed and still leave room for ample cultivation. Without doubt the crop when cultivated might endure longer than the pure stand from the standpoint of weed control, but whether it will winter as well as the broadcasted areas still remains to be determined.

A third cutting was made on September 8. Again the same thing holds true with regard to the yields on Plots A and B, respectively, the results were:

Plot A—1,500 lbs.
" B—1,400 "
" C— 540 "

Based upon the acre basis this becomes:

Plot A—750 lbs.
" B—700 "
" C—270 "

Plot C again was exceedingly poor, the foxtail having nearly choked it out.

The cost of harvesting the various plots and the subsequent profit realized from each method of seeding have been summarized in Table IX.

In calculating the profit no interest or tax has been charged for the land, and no cost of hauling the crop to market. It will be seen that Plot A, which cost the most to lay down, gave the highest return per acre, with an acre profit of $30.54, Plot B coming next in order with a profit of $24.41. Plot C was worked at a loss of $5.05 per acre, again emphasizing that growing alfalfa in rows as here tried was not feasible.

During the growing season abundant opportunity was afforded to carry out some chemical analyses on the variously seeded areas. Previous data seem to indicate that there is no difference between the digestibility of succeeding cuttings, although farmers generally prefer the second cutting. Also it was thought that perhaps the various methods of seeding might have some influence upon the protein content of the alfalfa crop. It was thought, especially, that the alfalfa grown in rows, being subject to less etiolating conditions than the broadcasted crop, as well as

Table IX

Receipts and Expenses for Different Methods of Seeding Alfalfa

PLOT A.—ALFALFA AND TIMOTHY.

RECEIPTS.		EXPENSES.	
First Cutting—		Laying down of plot,	$43 97
a. 3,618 lbs. alfalfa @ $20.00 per ton,		Harvesting 1st Crop—	
b. 3,082 lbs. timothy @ $20.00 per ton,	$67 00	a. 28 m. h. @ 20c.,	5 60
Second Cutting—		b. 24 h. h. @ 15c.,	3 60
5,080 lbs. alfalfa @ $20.00 per ton,	50 80	Harvesting 2d Crop—	
Third Cutting—		a. 38 m. h. @ 20c.,	7 60
1,500 lbs. alfalfa @ $20.00 per ton,	15 00	b. 17 h. h. @ 15c.,	2 55
		Harvesting 3d Crop—	
		a. 24 m. h. @ 20c.,	4 80
		b. 24 h. h. @ 15c.,	3 60
		Total Expenses,	$71 72
		Profit for Plot,	61 08
Total Receipts,	$132 80		$132 80
		Profit per Acre,	$30 54

PLOT B.—ALFALFA SEEDED SOLID IN 4-INCH DRILLS.

RECEIPTS.		EXPENSES.	
First Cutting—		Laying down of plot,	$43 13
5,900 lbs. alfalfa @ $20.00 per ton,	$59 00	Harvesting 1st Crop—	
Second Cutting—		a. 24 m. h. @ 20c.,	4 80
4,300 lbs. alfalfa @ $20.00 per ton,	43 00	b. 20 h. h. @ 15c.,	3 00
Third Cutting—		Harvesting 2d Crop—	
1,400 lbs. alfalfa @ $20.00 per ton,	14 00	a. 33 m. h. @ 20c.,	6 60
		b. 15 h. h. @ 15c.,	2 25
		Harvesting 3d Crop—	
		a. 22 m. h. @ 20c.,	4 40
		b. 20 h. h. @ 15c.,	3 00
		Total Expenses,	$67 18
		Profit for Plot,	48 82
Total Receipts,	$116 00		$116 00
		Profit per Acre,	$24 41

PLOT C.—SEEDED IN ROWS 30 INCHES APART.

RECEIPTS.		EXPENSES.	
First Cutting—		Laying down of plot,	$38 30
1,920 lbs. alfalfa @ $20.00 per ton,	$19 20	Harvesting 1st Crop—	
Second Cutting—		a. 9 m. h. @ 20c.,	1 80
1,500 lbs. alfalfa @ $20.00 per ton,	15 00	b. 7 h. h. @ 15c.,	1 05
Third Cutting—		*Harvesting 2d Crop*—	
540 lbs. alfalfa @ $20.00 per ton,	5 40	a. 11 m. h. @ 20c.,	2 20
		b. 5 h. h. @ 15c.,	75
		Harvesting 3d Crop—	
		a. 6 m. h. @ 20c.,	1 20
		b. 6 h. h. @ 15c.,	90
		Cultivating—	
Total Receipts,	$39 60	a. 7 m. h. @ 20c.,	1 40
Loss for Plot,	10 10	b. 14 h. h. @ 15c.,	2 10
Total Receipts,	$49 70	Total Expenses,	$49 70
Loss per Acre,	$5 05		

a larger area to draw plant-food from, would show a higher protein content. Again, the analysis of alfalfa grown in combination with timothy would perhaps show some interesting data. It has been shown by some investigators that a legume grown in association with a non-legume increases the protein content of the non-legume. On the other hand, no knowledge seems to have been disseminated indicating the influence of a non-legume upon the protein content of a legume.

In order to determine the influences above mentioned upon the protein content of the crops, 10 samples were gathered from each area and a separate analysis made of each sample of both the first and the second cuttings. The third cutting was made at such a time that the analytical data would not be comparable with the results from the previous cuttings.

An inspection of Table X reveals the fact that at the first cutting the protein content of both the broadcasted and the rowed areas was identically the same.

Table X

Relation of Method of Seeding and Crop Harvested to Protein Content. Figures Represent Percentage of Protein

FIRST CUTTING.			SECOND CUTTING.		
Plot A. Timothy and Alfalfa.	Plot B. Alfalfa.	Plot C. Alfalfa in Rows.	Plot A. 1.	Plot B. 2.	Plot C. 3.
13.09	16.37	18.73	16.87	19.37	17.09
13.08	16.88	16.49	15.93	20.14	15.60
12.56	17.18	16.97	10.81	19.73	14.50
17.02	18.43	18.01	16.87	20.80	16.37
15.40	18.07	17.18	17.18	19.31	16.37
13.21	18.01	16.25	15.62	18.16	15.38
13.56	17.30	16.87	17.50	19.32	18.10
14.65	17.31	17.46	17.50	18.32	17.81
17.81	15.62	16.87	16.80	19.21	16.74
17.31	17.18	17.93	17.65	19.65	16.58
Av. 14.76	17.23	17.27	16.87	19.40	16.65

The timothy-alfalfa area, on the other hand, showed a decrease *of nearly 2½ per cent in comparison with the nearest* comparable plot, *i. e.,* Plot B. The question at once presents itself, Has the legume given up part of its nitrogen to the non-legume, or has the growth of the alfalfa in this plot been such as to cause a low assimilation of nitrogen? Observations made at the time of cutting showed that, in general, the alfalfa on Plot B was of a somewhat finer quality than that on Plot A, the

heavier seeding, perhaps, inducing a more velvety, fine-stemmed growth. No plot having the same seeding as Plot A was available with which to compare the protein content of this plot, consequently, it cannot be definitely stated from the first cutting whether this depression in protein content was due to the growth with a non-legume or simply to the quantity of seed sown. However, when we look at the second cutting the protein content of both Plots A and B again show about the same difference, lending support to the evidence that the lessened protein content in Plot A is due, in a large measure, to the rate of seeding and perhaps not at all to the presence of the non-legume. Further work under more accurately controlled conditions is being done to determine this point. Comparing the protein content of Plot B at the first and second cuttings, an increase of about 2 per cent is noted in the second crop. This would give support for the preference that farmers generally have for the second cutting of alfalfa. The alfalfa in rows had approximately the same percentage of protein at both cuttings. A study of the protein content of the timothy which was growing in association with alfalfa showed a very slight, if any, increase over a similar crop without the presence of the legume, the percentage being: timothy alone 4.89 per cent, and timothy and alfalfa 4.93 per cent. The influence of lime upon the protein content of timothy showed an increase of 0.83 per cent, *i. e.*, the timothy on the limed area contained 4.89 per cent of protein, and that on the unlimed area 4.06 per cent.

The influence of lime upon the protein content of alfalfa was not so marked. The protein in the limed area was 17.27 per cent and in the unlimed area 13.81 per cent.

This work is to be continued next season in the hope that additional data may be accumulated with regard to the seeding and culture of this crop in New Jersey.

II

FARM MANAGEMENT

Four types of farming are being studied in New Jersey in addition to cost-accounting work that has been started during the past year. The study of one type, potato farming, has been completed and published as Bulletin 294. The study of the second type, general farming, is now being prepared for the press, while the third study, on dairy farming, is in the process of tabulation. The records of a number of truck farms are

ready for tabulation, but the assistance in the department is too meagre to permit a study of them at present. Since this work will be published later in bulletin form, further mention of it will not be made here.

REPORT OF THE DEPARTMENT OF FARM CROPS

Department of Farm Crops

CHAS. S. VAN NUIS, *Associate in Farm Crops*

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Report of the Department of Farm Crops

Chas. S. Van Nuis

I

INTRODUCTION

The growing season of 1916 was attended by many abnormalities, two of which will be mentioned in this report, namely, labor and climatic conditions.

The general scarcity of capable hands affected the cost of labor in preparing the soil and harvesting the crops. Because of the high rate of wages this year, the labor mentioned herein is calculated in man-hours and horse-hours, rather than in dollars and cents.

The shortage of motive power early in the season was the cause of serious delays, and much carting at inopportune times delayed the completion of the spring work. New land, acquired in April, and crop rotations demanding the plowing of some of the wettest and stoniest on the farm, added to the general derangement of tillage plans.

Adequate drainage for a 42-acre tract would permit of this stony section of the College Farm being laid down to permanent meadows, which in turn would permit other land to come under the plow more regularly. A tractor could then be used to better advantage and would relieve the situation considerably.

The adverse climatic conditions were even greater factors in retarding the season's work than the labor problem. In early spring the land dried and warmed slowly. The progress of farm work on May 7, 1916, was on a parity with that of April 1, 1915; a seasonal difference of five weeks.

The first oats-and-peas for 1916 were planted April 25. The first corn was planted May 26. The many rainy days in the spring and early summer prevented a normal sequence of farm operations, each overlapping its successor; some were changed and some omitted. The planting of oats-and-peas as late as May 12 interfered with the preparation of corn ground. Corn planting as late as June 15 interfered with gathering the alfalfa crop. The first cutting of alfalfa was made June 17, this late cutting adversely affecting the season's yield.

Beside several rains, an excessive amount of cloudy weather retarded the mid-summer work. Hay-making required an unusual number of operations, resulting in an increased cost and a poorer quality of product.

Cutting alfalfa and clover was deferred until both crops were lodged; the yield per cutting was thereby decreased and part of the third cutting of alfalfa omitted.

II

CORN

Thirty-five acres of the tracts known as the College Farm Additions, 20 acres of which were alfalfa sod, were planted to corn. Twelve acres had been planted to corn three or more seasons, and 3 acres, newly acquired, had been abandoned for a number of years.

Two 5-acre tracts of alfalfa sod were winter plowed, one being manured and treated with 350 pounds of acid phosphate and 150 pounds of salt per acre, planted with a Monmouth County yellow dent corn, and yielded 46.55 tons of silage, cut when the corn was in the dough stage. All operations occupied 411½ man-hours and 491 horse-hours. The other 5-acre tract was treated with 350 pounds of acid phosphate and 150 pounds of salt per acre. A short season variety of Reid's Yellow Dent corn was used, which was nearly matured when cut, and yielded 18.24 tons of silage. All operations consumed 250 man-hours and 309 horse-hours.

The remaining 10 acres of alfalfa sod devoted to corn were plowed in June, after considerable alfalfa was cut from the portions where the yield was heaviest. The fertilizer treatment was 350 pounds of acid phosphate and 150 pounds of salt per acre. The variety of corn used was Fogg's White, planted June 15 and harvested when the corn was beginning to glaze. The yield was 88.12 tons of silage. All operations occupied 614 man-hours and 787 horse-hours.

Twelve acres of old corn ground were manured and, after plowing, treated with 250 pounds of acid phosphate, 150 pounds of nitrate of soda and 100 pounds of salt per acre. The variety planted was Fogg's White. The yield was 63.27 tons of silage. The corn was in the glazed stage. All operations occupied 755½ man-hours and 1,097 horse-hours.

The remaining three acres of the corn crop was an abandoned field of sandy loam and the fertilizers consisted of 250 pounds

of acid phosphate, 150 pounds of nitrate of soda and 100 pounds salt per acre. The variety used was a Hunterdon County white-cap. The yield was 15.89 tons, nearly matured, and was cut for ensilage. The time of all operations was 197½ man-hours and 202 horse-hours.

III

OATS-AND-PEAS

Seventeen and one-half acres on the College Farm Additions were planted to oats-and-peas.

Fourteen acres of corn stubble were manured and treated with 250 pounds of acid phosphate, 150 pounds of nitrate of soda and 100 pounds of salt per acre. The labor involved in all operations for plowing and planting, including manuring and fertilizing, were 307½ man-hours and 572 horse-hours. Gathering 43,970 pounds for silage was accomplished with 212 man-hours and 152 horse-hours.

Gathering 5,920 pounds of green forage and harvesting approximately 17 tons of hay occupied 134 man-hours and 146 horse-hours.

The remaining 3½ acres of oats-and-peas were planted in an abandoned field which had grown up to weeds and briars, was somewhat stony and included a gravelly knoll that contained very little organic matter. This area was treated with 250 pounds of acid phosphate, 150 pounds of nitrate of soda and 100 pounds of salt per acre. All operations, fitting the ground and planting, occupied 81 man-hours and 154 horse-hours. Harvesting approximately 5¼ tons of hay required 46 man-hours and 52 horse-hours.

IV

ALFALFA

The total area devoted to alfalfa was 18 acres. Eight and one-half acres were old sods, of 3 or more years' standing, and 9½ acres of 1-year sods.

Of the old alfalfa sod, 4½ acres were treated with 300 pounds of acid phosphate, 100 pounds of salt and 200 pounds of oyster-shell lime; 2 acres were top-dressed as above plus manuring; 2 acres were for a temporary stand only and were not treated. The 2 acres specially treated with manure were located on a hill where it is desirable to keep a stand as long as possible to prevent erosion.

Applying the lime and fertilizers to the above-mentioned 6½ acres consumed 28 man-hours and 39 horse-hours. Harvesting three cuttings on 6½ acres and two cuttings on 2 acres required 376 man-hours and 279 horse-hours. The total yield was 27.15 tons of hay.

There were two plots of alfalfa of the 1915 seeding; 1 plot of 3½ acres on a sandy loam which was manured and treated with 2 tons of oyster-shell lime, plus 300 pounds of acid phosphate, 100 pounds of tankage and 100 pounds of salt. The time consumed in spreading these ingredients, plowing, fitting the soil and planting, was 133½ man-hours and 267 horse-hours.

A plot of 6 acres of Alloway clay was planted about the same time with the same treatment as the above, less the manuring; and the total expenditure of time was 170 man-hours and 263 horse-hours.

Harvesting three cuttings from 3½ acres mentioned above required 131 man-hours and 161 horse-hours. The yield of hay was 11.45 tons. Harvesting 3 cuttings from 6 acres mentioned above required 187 man-hours and 123 horse-hours. The yield was 16.48 tons of hay.

V

TIMOTHY AND MIXED HAY

Thirty-seven acres is the area devoted to hay, of which 25 acres are principally timothy and 12 acres of timothy somewhat mixed with clover.

The 10-acre meadow, of 4 years' standing, was top-dressed with 250 pounds of acid phosphate, 150 pounds of nitrate of soda and 100 pounds of salt and was rolled in the spring. These operations occupied 37 man-hours and 34 horse-hours. From this area was harvested 27.87 tons of hay, occupying 234 man-hours and 197 horse-hours. The late summer being very dry little timothy aftermath grew on this meadow, but a considerable quantity of "volunteer" alfalfa has been yearly increasing and was harvested this year as pure alfalfa hay, the yield being 2.57 tons. It required 10 man-hours and 14-horse-hours for the harvesting and storing.

Fifteen acres of timothy meadow, with defective under-draining and much fouled with weeds, were top-dressed with 250 pounds of acid phosphate, 150 pounds of nitrate of soda and 100 pounds of salt, and rolled in the spring. The expenditure of time was 47 man-hours and 56 horse-hours. This area yielded

approximately 26 tons of hay, requiring 218 man-hours and 204 horse-hours for the harvesting.

Of the remaining 12 acres occupied by the hay crop, 9 acres were manured and rolled, and 3 acres were rolled but not treated with manure or fertilizer. Both fields contained a considerable quantity of clover. The manuring and rolling of the 9 acres required 33 man-hours and 66 horse-hours. The total yield of hay from the 12 acres was 22.03 tons, requiring 263 man-hours and 210 horse-hours for the operations.

VI

OTHER CROPS

Beside the above, there were forage crops furnished from the College Farm to the dairy department, as follows:

Green rye,	19,550 lbs.
" grass,	1,080 "
" clover,	1,435 "
" soybeans,	10,360 "

Of the latter item 7,700 pounds were put into a silo with corn silage.

Some small areas were devoted to alternations of rye and soybeans, permitting two crops per year on the same ground. The rye not fed green to the cattle was cut for straw just after the rye headed, and was immediately followed by soybeans for green forage, or to be plowed under as green manure.

REPORT OF CRANBERRY INVESTIGATIONS

Cranberry Investigations

Fidel P. Schlatter, B.Sc., Research Assistant

*Franklin O. Church, B.Sc., Research Assistant

* Appointed November 1, 1915.

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Report of Cranberry Investigations

I

EXPERIMENTS WITH FERTILIZERS ON CRANBERRIES

F. P. Schlatter

INTRODUCTION

The experiments with fertilizers on cranberries, started in 1913, were continued in 1915 in accordance with the original plan, and, with some modification, in 1916. The plan and explanation of the experiments are to be found in the Annual Report of the Experiment Station for 1913.

FERTILIZER TESTS IN 1915

Three annual applications of fertilizers have been made, the last, being made in the spring of 1915. At the end of 1915, the data obtained and the appearance of the vines indicated that the amounts of fertilizers used had been too great. Excessive vine growth had taken place at the expense of fruit production, and for this reason the fertilizer treatment was omitted in 1916. The reserve supply of materials in the soil was thought sufficient to furnish food during the present season, and would show, perhaps, that lighter applications might be more desirable. To modify the plan of the experiment still further, and to improve the abnormal conditions of growth induced by previous applications of fertilizer, pruning was thought advisable. Wherever the vines were too heavy, and especially where runners were present in great amounts, pruning was done. There has thus been introduced into the experiment another factor that has influenced the results for the season of 1916. The fertilizer is not the only limiting factor, and it will be more difficult to interpret the results for 1916 properly. For the purpose of studying the effect of the fertilizer primarily, therefore, attention might best be centered on the results of 1915.

The only data in connection with Series D and E, located at Jamesburg and Belle Plain, respectively, are those which record

the weights obtained in the field at picking time. At Whitesbog, however, it has been possible not only to obtain the field weights but also the records of size of the berries, and to study the keeping quality of the fruit by storing the entire crop of the plots and sorting the berries at a later date. The tables in this report will be found to contain, therefore, the picking records of all five series in 1915 and 1916, record of the size tests on Series A, B and C for 1915 and 1916, and the data obtained after sorting the 1915 crop. It is not possible at this time to give the results of the sorting of the 1916 crop, as that process has not been completed. The field weights include the entire crop of good, rotten and damaged berries. The size represents an average of eight or more counts, made in the field at picking time and obtained by the use of the usual cup furnished to the Cranberry Growers' Co. by the American Cranberry Exchange. All weights are recorded in pounds, a pound being equal to one quart, with 100 pounds to a barrel.

Since the only data available for Series D and E are the picking records obtained in the field, a table showing similar records for all five Series will first be given, the later tables dealing with the sorting operations and furnishing other information. It may be stated here that the conclusions drawn from Table I will not in all cases coincide with those drawn from Table II, which deals with the records obtained after sorting the berries from Series A, B and C. The heavy vine growth produced by the fertilizers furnished ideal conditions for the growth of the fungi producing rot, and in almost all cases the fertilized plots yielded greater amounts of rotten berries than the checks. This must be taken into account, as the amount of salable berries is of prime interest to the grower. In consideration of the amount of salable berries remaining after sorting, therefore, the value of the fertilizers, based on Table II, would not in all cases be so great as if based on Table I alone.

Upon examination of Table I, it will be found that in Series A, sandy bottom, with the possible exception of the materials furnishing potash alone, almost universal increases were obtained from the use of fertilizers. The figures show that particularly gratifying results were obtained from the use of complete fertilizers, nitrate of soda, dried blood, cottonseed meal, acid phosphate and rock phosphate.

On Series B, C, D and E, results obtained seemed to indicate that mud bottoms are plentifully supplied with all materials excepting phosphorus. Complete fertilizers and nitrogen, when added, caused rank growth of vines, especially runners, at the

Table I

Field Weights of All Five Series, 1915

Number of Plot	FERTILIZER TREATMENT.	Series A, "Savannah Bottom," Whitesbog, N. J.	Series B, Mud Bottom, Whitesbog, N. J.	Series C,* Iron Ore Bottom, Whitesbog, N. J.	Series D, Mud Bottom, Jamesburg, N. J.	Series E, Mud Bottom, Belle Plain, N. J.
		lbs.	lbs.	lbs.	lbs.	lbs.
1	14 lbs. Nitrate of Soda,	314.25	131.00	189.38	70.75	116.50
2	Nothing,	150.13	199.38	271.50	284.00	52.00
3	10 lbs. Ammonium Sulphate,	208.75	119.25	170.63	183.75	34.50
4	Nothing,	167.75	117.50	164.25	261.75	60.75
5	20 lbs. Dried Blood,	385.88	277.63	201.50	69.50	44.75
6	Nothing,	194.00	142.63	221.75	108.75	74.00
7	20 lbs. Cottonseed Meal,	391.13	248.63	207.03	74.50	118.50
8	Nothing,	213.00	218.88	217.75	107.50	89.25
9	14 lbs. Nitrate of Soda; 25 lbs. Acid Phosphate; 10 lbs. Muriate of Potash,	342.63	170.88	185.50	79.00	80.50
10	Nothing,	208.75	214.56	245.13	203.25	61.00
11	10 lbs. Ammonium Sulphate; 25 lbs. Acid Phosphate; 10 lbs. Muriate of Potash,	330.50	119.25	126.50	26.50	11.50
12	Nothing,	293.50	221.25	218.50	118.50	17.25
13	20 lbs. Dried Blood; 25 lbs. Acid Phosphate; 10 lbs. Muriate of Potash,	588.25	195.25	157.13	118.50	30.25
14	Nothing,	344.00	279.00	123.00	165.00	28.00
15	30 lbs. Cottonseed Meal; 25 lbs. Acid Phosphate; 10 lbs. Muriate of Potash,	733.75	145.13	124.88	103.00	53.75
16	Nothing,	314.88	276.00	198.13	150.25	132.25
17	25 lbs. Acid Phosphate,	411.63	254.88	185.50	207.00	70.00
18	Nothing,	215.31	245.38	175.13	232.00	118.50
19	25 lbs. Basic Slag,	292.00	353.13	199.75	166.50	119.00
20	Nothing,	185.25	323.63	180.00	208.25	95.50
21	15 lbs. Rock Phosphate,	355.50	379.56	318.13	215.75	126.25
22	Nothing,	177.88	330.56	110.75	302.00	125.50
23	15 lbs. Steamed Bone,	262.75	324.00	163.13	114.50	101.25
24	Nothing,	216.50	287.88	150.37	46.00	95.50
25	30 lbs. Bone Meal (2–30.); 10 lbs. Ammonium Sulphate; 10 lbs. Muriate of Potash,	339.25	21.00	149.13	74.50	19.25
26	Nothing,	276.50	71.50	192.88	32.00	30.25
27	25 lbs. Basic Slag; 14 lbs. Nitrate of Soda; 10 lbs. Muriate of Potash,	431.75	14.25	161.00	107.50	13.50
28	Nothing,	292.25	57.25	197.50	13.50	15.25
29	15 lbs. Phosphate Rock; 10 lbs. Ammonium Sulphate; 10 lbs. Muriate of Potash,	382.63	9.75	127.63	120.00	7.25
30	Nothing,	387.18	40.63	233.25	....	56.25
31	*15 lbs. Steamed Bone; 10 lbs. Ammonium* Sulphate; 10 lbs. Muriate of Potash,	566.50	11.13	151.50	58.00	14.00
32	Nothing,	323.50	43.13	139.00	67.00	49.50
33	10 lbs. Muriate of Potash,	310.63	66.50	146.88	180.50	79.75
34	Nothing,	269.50	90.75	226.38	227.50	110.50
35	10 lbs. Sulphate of Potash,	203.00	28.50	344.13	97.00	70.25
36	Nothing,	134.13	80.43	206.38	112.00	60.00
37	42 lbs. Kainit,	145.00	64.38	349.81	65.00	28.50
38	Nothing,	165.00	89.00	317.13	81.00	11.50
39	10 lbs. Sulphate of Potash; 10 lbs. Ammonium Sulphate; 25 lbs. Acid Phosphate,	333.13	82.50	135.37	19.00	6.50
40	Nothing,	232.50	52.50	315.00	91.00	40.75
41	42 lbs. Kainit; 10 lbs. Ammonium Sulphate; 25 lbs. Acid Phosphate,	252.88	312.50	152.13	15.50	8.75
42	Nothing,	199.75	133.75	219.75	57.50	63.00

* The plots in Series C, being only half as large as the plots of the other four series, received only half the amounts of fertilizer given in the above outline.

expense of fruit production. Potash seemed to cause very little response. With the exception of materials furnishing phosphorus, then, the application of fertilizers to mud bottoms seemed to be undesirable.

Table II

Tests for Size and Sorting Records, 1915, Whitesbog, N. J.

PLOT No.	Series A. Savannah Bottom.			Series B. Deep Mud Bottom.			Series C. Iron Ore Bottom.		
	Pounds of Good Berries.	Pounds of Rotten Berries.	Berries Per Cup.	Pounds of Good Berries.	Pounds of Rotten Berries.	Berries Per Cup.	Pounds of Good Berries.	Pounds of Rotten Berries.	Berries Per Cup.
1,	277.38	16.25	104	103.00	15.75	[illegible]	164.75	9.37	84
2,	188.75	6.75	113	132.75	11.00	111	241.25	13.75	87
3,	182.00	12.88	117	87.25	23.00	108	155.75	10.25	88
4,	181.50	6.25	112	120.63	13.75	104	146.87	7.63	89
5,	369.10	13.00	107	102.00	35.00	102	171.87	12.37	84
6,	208.00	9.13	114	147.25	24.75	110	160.75	7.25	87
7,	362.75	15.13	104	174.25	57.00	97	172.50	17.50	87
8,	195.00	8.88	114	140.50	16.50	99	175.37	7.50	91
9,	415.50	41.25	88	122.50	35.63	91	98.50	61.25	81
10,	187.13	9.63	108	173.50	11.37	90	162.63	10.37	84
11,	311.75	30.00	83	57.75	33.50	85	63.25	51.00	74
12,	253.75	18.38	98	177.00	29.50	95	233.63	17.13	85
13,	508.88	41.25	93	91.50	78.63	87	70.25	37.25	81
14,	311.63	19.38	106	197.50	57.75	90	98.75	8.63	88
15,	663.13	39.38	92	104.25	83.13	82	80.75	31.25	79
16,	293.43	15.63	108	168.13	81.50	97	176.13	10.37	85
17,	415.13	18.38	104	147.87	110.75	90	136.75	9.25	87
18,	196.75	8.63	108	125.67	58.25	97	168.67	8.13	89
19,	262.00	12.25	108	200.50	130.50	93	175.13	8.25	92
20,	165.56	7.63	108	193.87	97.13	94	159.87	7.00	91
21,	318.38	15.25	98	216.25	62.25	94	241.00	12.75	86
22,	121.25	6.00	113	238.25	56.25	99	106.25	5.63	84
23,	236.50	11.25	108	263.25	56.50	96	141.25	9.87	85
24,	220.88	14.75	109	256.50	30.75	103	134.87	6.37	85
25,	281.63	46.75	86	10.63	7.00	84	122.13	17.50	80
26,	231.63	9.13	104	52.00	12.75	92	203.37	15.63	86
27,	369.63	43.88	83	11.50	4.00	87	108.50	41.00	78
28,	237.75	25.75	100	46.87	5.50	94	178.25	12.75	88
29,	278.75	70.00	80	6.50	2.75	71	80.37	31.25	77
30,	320.50	25.88	104	33.50	6.63	89	202.13	14.75	86
31,	432.50	73.88	83	7.50	4.25	73	89.00	50.50	75
32,	286.75	26.75	107	36.25	4.75	98	122.87	7.50	91
33,	208.81	17.00	102	37.37	5.25	92	126.13	8.50	82
34,	242.50	25.88	109	84.00	8.75	93	203.37	7.25	89
35,	175.75	10.25	111	60.13	4.87	97	168.50	11.50	85
36,	108.88	9.00	117	70.37	4.63	93	269.50	26.13	88
37,	140.38	13.25	112	54.75	4.00	92	255.43	66.75	91
38,	142.43	11.63	111	77.25	5.37	95	258.13	36.75	93
39,	250.88	44.25	91	69.13	7.50	99	48.25	38.63	85
40,	199.25	17.00	110	45.93	4.75	99	241.37	46.37	92
41,	190.25	30.00	96	29.00	6.00	85	110.00	71.25	86
42,	160.88	14.50	110	117.13	11.00	97	179.25	25.37	92

Table II furnishes data to show the amounts of good berries and of rotten berries obtained at sorting time, and the size tests, for Series A, B and C. In Series A, increases were obtained on all fertilized plots excepting four—No. 3, which received am-

monium sulfate; No. 29, which received complete fertilizer, and No. 33 and 35, which received potash. Plot 3 seemed to be in a generally poor condition, the berries smaller, and the vines less vigorous. With these four exceptions, however, the fertilizers met with very favorable response.

On Series B and C, however, quite the reverse was true. In general, the strength of the plants was all turned into vine growth, especially runners, with less fruit production. This condition was especially to be found on the plots treated with nitrogen compounds and complete fertilizers. In Series B, Plot 7, which received cottonseed meal, Plot 39, which received complete fertilizer, and the plots which received phosphorus compounds alone were the only ones which responded favorably. In Series C, the only plots which showed any material increase were No. 19, 21 and 23, which received phosphorus compounds. This bog is underlaid with iron ore, and it is possible that in the past, all the phosphorus of the soil has been fixed in the form of an insoluble iron phosphate, unavailable to the plants. If so, this will in a way explain the response given to phosphorus compounds.

It will be noticed that on all three series in general, the size of the fruit was increased by the fertilizer, special increase being obtained from the use of complete fertilizers, and particularly on Series A, where the bog is naturally more deficient in plant-food than in Series B and C. A further point of interest and of practical value is found in the fact that greater amounts of rotten berries were found on the fertilized plots. Wherever heavy vine growth had taken place the result was a poor condition of aeration and good conditions for the development of the fungi causing rots.

Tests with Lime, Copper, Maganese and Sulfur

Table III shows the results obtained from the use of these four materials on sandy soil (Series AX) and on mud bottom (Series BX), at Whitesbog, on 1/200 acre plots. On such small plots it is practically impossible to make plant-food the only limiting factor, and for this reason the results were somewhat erratic; but the increases obtained from the use of burned lime on ground limestone are worthy of notice. They seem to show that there is a limit to the acidity which cranberry soils should possess, and that perhaps acid soils are not so essential as is popularly supposed. Table IV shows some considerable gains.

Table III

Results of Tests with Lime, Copper, Manganese and Sulphur

SERIES AX—SAVANNAH BOTTOM

Plot No.	TREATMENT.	Field Weight in Pounds.	
		1915	1916
1	Check, ...	11.75	8.38
2	0.125 lbs. $CuSO_4$, ...	21.50	19.75
3	Check, ...	27.87	19.75
4	0.25 lbs. $CuSO_4$, ...	4.37	1.50
5	Check, ...	11.50	8.13
6	0.5 lbs. $CuSO_4$, ...	17.37	15.38
7	0.5 lbs. $MnSO_4$, ...	2.13	1.50
8	1.0 lbs. $MnSO_4$, ...	5.00	2.00
9	Check, ...	9.63	6.00
10	Check, ...	6.13	5.63
11	2.0 lbs. $MnSO_4$, ...	4.00	2.25
12	4.0 lbs. $MnSO_4$, ...	2.00	1.88
13	0.5 lbs. Sulfur, ...	17.37	8.25
14	1.0 lbs. Sulfur, ...	6.75	4.13
15	Check, ...	8.75	3.75
16	Check, ...	16.63	10.13
17	2 lbs. Sulfur, ...	6.56	1.38
18	4 lbs. Sulfur, ...	0.50	....
19	5 lbs. Gr. Limestone,..	33.63	22.88
20	10 lbs. Gr. Limestone,	28.00	20.63
21	Check, ...	11.00	9.50
22	Check, ...	29.50	23.38
23	20 lbs. Gr. Limestone.	36.50	25.38
24	40 lbs. Gr. Limestone.	30.75	21.50
25	2.5 lbs. Burned Lime,..	29.75	19.50
26	5.0 lbs. Burned Lime,..	30.50	20.38
27	Check, ...	23.75	18.13
28	Check, ...	36.13	14.38
29	10 lbs. Burned Lime,..	35.75	25.38
30	20 lbs. Burned Lime,..	25.63	18.25

SERIES BX—MUD BOTTOM

Plot No.	TREATMENT.	Field Weight in Pounds.	
		1915	1916
1	0.125 lbs. $CuSO_4$, ...	32.75	8.75
2	0.25 lbs. $CuSO_4$, ...	34.00	9.63
3	0.5 lbs. $CuSO_4$, ...	22.37	7.88
4	Check.	20.00	7.50
5	Check.	48.25	6.38
6	0.5 lbs. $MnSO_4$, ...	39.75	8.50
7	1.0 lbs. $MnSO_4$, ...	31.63	7.88
8	2.0 lbs. $MnSO_4$, ...	24.13	7.25
9	4.0 lbs. $MnSO_4$, ...	29.00	4.75
10	Check, ...	34.00	7.50
11	5 lbs. Gr. Limestone,..	38.00	14.25
12	10 lbs. Gr. Limestone,	33.75	10.13
13	20 lbs. Gr. Limestone,	30.80	3.88
14	40 lbs. Gr. Limestone,	41.87	6.88
15	0.5 lbs. Sulfur, ...	....	5.63
16	1.0 lbs. Sulfur,.......	28.50	2.50
17	Check.	18.63	1.75
18	2 lbs. Sulfur.	26.25	2.50
19	4 lbs. Sulfur.	31.63	2.25
20	Check.	24.13	3.63
21	2.5 lbs. Burned Lime,	16.50	3.25
22	Check.	13.75	2.13
23	5 lbs. Burned Lime, ..	13.25	4.25
24	Check.	14.25	2.25
25	10 lbs. Burned Lime,..	28.00	2.63
26	Check.	12.63	1.50
27	20 lbs. Burned Lime,..	14.87	3.00
28	Check, ...	12.13	2.00
29	Check.	9.13	2.25
30	Check, ...	19.00	1.88

Table IV

Effect of Lime on Cranberries, 1915

SERIES AX—SANDY BOTTOM

TREATMENT	Increase or Decrease Over Nearest Check or Checks. Per Cent.
5 lbs. Ground Limestone,	+ 44.8
10 lbs. " "	+ 47.0
20 lbs. " "	+ 70.4
40 lbs. " "	+ 76.9
2.5 lbs. Burned Lime, ...	— 9.3
5 lbs. " " ...	+ 36.8
10 lbs. " " ...	+ 19.4
20 lbs. " " ...	+ 7.9

SERIES BX—MUD BOTTOM

TREATMENT	Increase or Decrease Over Nearest Check or Checks. Per Cent.
5 lbs. Ground Limestone,	+ 2.5
10 lbs. " "	— 0.8
20 lbs. " "	+ 60.1
40 lbs. " "	+ 19.8
2.5 lbs. Burned Lime, ...	+ 24.1
5 lbs. " " ...	— 1.0
10 lbs. " " ...	+ 120.4
20 lbs. " " ...	+ 56.4

Note.—(+) indicates increase; (—) decrease.

Since it has been shown that sandy soils are the only ones that generally respond to fertilizer treatment, it seems well to include a table showing the relative values of the fertilizing materials that have given the most notable results in the series located on sandy bottom, both as to yield of salable fruit and as to size.

Table V

Relative Values of the Fertilizing Materials that Have Given the Most Notable Increases, in Order. Series A (See note.)

FROM STANDPOINT OF YIELD (SOUND BERRIES).			FROM STANDPOINT OF SIZE (FIELD COUNT).		
Plot No.	TREATMENT.	Gain Over Average of Adjacent Checks. Per Cent.	Plot No.	TREATMENT.	Gain Over Average of Adjacent Checks. Per Cent.
21	15 lbs. Rock Phosphate, ...	121	29	15 lbs. Rock Phosphate; 10 lbs. Ammonium Sulfate; 10 lbs. Muriate of Potash, ...	21.0
15	30 lbs. Cottonseed Meal; 25 lbs. Acid Phosphate; 10 lbs. Muriate of Potash, ...	119	31	15 lbs. Steamed Bone; 10 lbs. Ammonium Sulfate; 10 lbs. Muriate of Potash, ...	21.3
9	14 lbs. Nitrate of Soda; 25 lbs. Acid Phosphate; 10 lbs. Muriate of Potash, ...	117	9	14 lbs. Nitrate of Soda; 25 lbs. Acid Phosphate; 10 lbs. Muriate of Potash, ...	20.7
5	20 lbs. Dried Blood, ...	89	11	10 lbs. Ammonium Sulfate; 25 lbs. Acid Phosphate; 10 lbs. Muriate of Potash, ..	19.5
7	30 lbs. Cottonseed Meal, ...	80	25	30 lbs. Bone Meal; 10 lbs. Ammonium Sulfate; 10 lbs. Muriate of Potash, ...	19.5
13	20 lbs. Dried Blood; 25 lbs. Acid Phosphate; 10 lbs. Muriate of Potash, ...	80	27	25 lbs. Basic Slag; 14 lbs. Nitrate of Soda; 10 lbs. Muriate of Potash, ...	19.6
17	25 lbs. Acid Phosphate, ...	69	15	30 lbs. Cottonseed Meal; 25 lbs. Acid Phosphate; 10 lbs. Muriate of Potash, ...	14.1
27	25 lbs. Basic Slag; 14 lbs. Nitrate of Soda; 10 lbs. Muriate of Potash, ...	58	41	42 lbs. Kainit; 10 lbs. Ammonium Sulfate; 25 lbs. Acid Phosphate, ...	12.8
1	14 lbs. Nitrate of Soda, ...	47	21	15 lbs. Rock Phosphate, ...	11.31
19	25 lbs. Basic Slag, ...	44	7	30 lbs. Cottonseed Meal, ...	9
			1	14 lbs. Nitrate of Soda, ...	8

Note.—This table deals with Series A only, and will be of practical value for sandy soils only.

General Results for 1915

Table VI, giving the general results for 1915, brings out the following points:

1. In Series A, the application of fertilizers resulted in an increase in weight of salable berries of 49.15 per cent, and an increase in size of 10.25 per cent.

2. In Series B, the application of fertilizers resulted in a decrease of weight of salable berries of 28.7 per cent, and an increase in size of 7.13 per cent.

3. In Series C, the application of fertilizers resulted in a decrease in weight of salable berries of 27.2 per cent, and an increase in size of 5.07 per cent.

4. In all three series there was an increase in weight of rotten berries. On Series A the increased weight of salable berries much more than counteracted this, but in Series B and C this point became an important one.

Table VI

General Results of Series A, B and C, Whitesbog, N. J., 1915

SERIES	Total Weight of Good Berries in Series, lbs.		Total Weight of Rotten Berries in Series, lbs.		Percentage of Good Berries		Size of Fruit		
	Fertilized Plots	Check Plots	Fertilized Plots	Check Plots	Fertilized Plots	Check Plots	Fertilized Average Count	Check Plots Average Count	% of Increase of Fertilized Plot Over Check Plot
A, ...	6657.0	4463.3	615.50	298.50	91.5	93.8	97.6	108.7	10.25
B, ...	1956.0	2745.1	767.25	553.62	71.8	83.2	90.6	97.5	7.13
C, ...	2784.1	3823.5	607.25	302.25	82.1	92.7	83.6	88.1	5.07

PERCENTAGE OF INCREASE (+) OR DECREASE (—), IN GOOD BERRIES OF FERTILIZED PLOTS OVER CHECKS

SERIES	Whole Series Per Cent.	Complete Fertilizer Per Cent.	Nitrogen Compounds Per Cent.	Phosphorus Compounds Per Cent.	Potash Compounds Per Cent.
A, ...	+ 49.15	+ 49.4	+ 54.02	+ 72.68	+ 6.30
B, ...	— 28.70	— 51.3	— 13.79	+ 1.64	— 34.27
C, ...	— 27.20	— 51.8	— 8.19	+ 21.80	— 24.75

5. Series A is the only one which showed a general increase in yield, both in the whole series and in the various fertilizer groups. On Series B and C, there is a decrease for all fertilizer groups except the phosphorus compounds, which on Series B produced an average increase of 1.64 per cent, and on Series C an increase of 21.8 per cent.

Closing Remarks

After an examination of the foregoing tables it seems evident that the amounts of fertilizer applied for three seasons were too great, and that some modification of the original plan ought to be made if the experiments were to be continued. It seems clear, also, that before fertilizers are added to cranberry

soils, the character of the soil must be taken into consideration. A sandy soil seems to be the only one which generally responds to fertilizers, though mud bottoms seem to be benefited by the addition of phosphorus. Sandy soils appear to be deficient in nitrogen and phosphorus, and the mud bottoms deficient in phosphorus. For this reason nitrogen in the organic form, as dried blood or cottonseed meal, and phosphorus in the form of rock phosphate, seem to be the most desirable additions.

EXPERIMENTS IN 1916

As before stated, the vines at the end of the season of 1915 were in a very undesirable condition. Excessive growth, especially of runners, had taken place as the result of previous applications, and pruning seemed necessary to restore the vines to more normal conditions. For this reason pruning was done on all plots that seemed to need it. A few of the plots were divided lengthwise, and the upper, or east half, pruned. The vines that were removed were weighed in order to furnish some indication as to the severity of the pruning. While the object of the work was primarily to remove the runners, nevertheless, in the operation many uprights were removed. This should make a difference in the yield; if so, those plots divided lengthwise will show it.

Furthermore, the usual fertilizer treatment was omitted in 1916 in order to allow the vines to use up the reserve supply of plant-food present in the soil as the result of previous applications.

The following list shows which plots were pruned, and the weight of the vines removed.

SERIES A

A— 1—	55.50 lbs.	
A— 5—	68.30 "	
A— 7—	53.75 "	
A— 9—	102.00 "	
A—11—	77.00 "	
A—13—	33.75 "	(upper, or east half)
A—15—	34.00 "	" " " "
A—25—	68.00 "	
A—27—	97.50 "	
A—29—	88.00 "	
A—31—	86.00 "	
A—29—	60.50 "	
A—41—	45.00 "	

SERIES B

B— 2—	66.75 lbs.
B— 3—	93.50 "
B— 5—	95.25 "

B— 6—	52.00	"	
B— 7—	121.75	"	
B— 9—	111.25	"	(upper, or east half, pruned)
B—10—	56.50	"	" " " " "
B—11—	71.00	"	" " " " "
B 13, B 14, B 15	370.00	"	combined
B—17—	140.25	lbs.	
B—19—	129.75	"	
B—20—	114.25	"	
B—23—	137.00	"	
B—24—	148.00	"	
B—27—	174.00	"	
B—29—	150.75	"	
B—30—	100.00	"	
B—31—	191.25	"	
B—33—	128.75	"	
B—34—	132.75	"	
B—35—	117.75	"	
B—38—	134.25	"	
B—39—	230.75	"	
B—41—	229.25	"	
B—42—	163.50	"	

SERIES C

C— 1—	36.75	lbs.	
C— 2—	59.50	"	
C— 6—	43.00	"	
C— 7—	46.75	"	
C— 9—	61.75	"	
C—10—	46.75	"	
C—11—	80.50	"	
C—12—	40.25	"	
C—13—	81.50	"	
C—15—	82.75	"	
C—21—	60.00	"	
C—27—	26.75	"	(upper, or east half)
C—29—	19.75	"	" " " "
C—30—	15.50	"	" " " "
C—31—	39.75	"	
C—36—	68.00	"	
C—37—	64.75	"	
C—39—	111.00	"	
C—40—	30.00	"	" " " "
C—41—	27.00	"	" " " "

The amount of vines removed gives some indication of the condition of the vines previous to pruning, as only necessary amounts were removed. The vines on Series B were much heavier; consequently the pruning was more severe.

Vine Growth in 1916

That there was a reserve of food supply in the soils as a remnant of previous applications, was evident from the differences in the young growth of uprights soon after the water was drawn

from the bogs in the spring of 1916. The stage of growth on certain fertilized plots was in striking contrast to that on the check plots and on the surrounding bog. The uprights were larger in size and greater in number. Briefly stated, on all three series the complete fertilizers produced the greatest amount of young growth. Of the materials furnishing nitrogen only, dried blood and cottonseed meal produced the greatest growth. Potash caused little, if any, difference; and the effects of the phosphate fertilizers were noticeable only on Series C, the bog that responded to phosphorus in 1915.

Observations made at different times during the growing season of 1916 showed that the differences in the appearance of the vines were relatively the same as they were at the beginning of the season. On all plots that had received complete fertilizer, heavy new growth had taken place. On the plots that had received single fertilizers, noticeable, though not striking differences, were present. Phosphorus caused improvement over the checks, especially on the bog underlaid with iron ore. Of the nitrogenous materials, dried blood and cottonseed meal caused increased growth, while potash produced only slight increased growth.

The pruning seemed to have had little noticeable effect on the vegetation. Necessarily, some of last year's wood was removed in the process, but the new growth that took place showed little damage. Without doubt many buds were removed that would have produced fruit this season; but the vines were stimulated and more uprights were produced during the past season, which condition should cause an increase in fruit production in 1917. Consequently, while the effect during the past season has been to set the vines back to some extent, on the whole, the pruning has improved the vines for future fruit production.

Yield of Fruit in 1916

Before the figures for 1916 are given a few remarks will aid in more clearly understanding the data and in making comparisons with the data for 1915.

On account of the many environmental factors to which a cranberry bog is subject, it is difficult to make plant-food the only limiting factor. Late drawing of the winter flowage, localized frost or insect depredations, sun-scalding and other factors, may greatly reduce yields which, if caused by differences in plant-food only, would be much lighter. In such cases, compari-

son may, or may not, still be possible, depending on the severity of the reduction. As illustrations of this, it might be mentioned that from Series A and B, the water was drawn very late in the

Table VII

Field Weights for All Five Series and Size Tests for Series A, B and C, 1916

	Series A, Sandy Bottom, Whitesbogs		Series B, Mud Bottom, Whitesbogs		Series C, Iron-Ore Bottom, Whitesbogs		Series D, Mud Bottom, Jamesburg	Series E, Mud Bottom, Belle Plain
Plot No.	Field Weight in Pounds	Berries Per Cup	Field Weight in Pounds	Berries Per Cup.	Field Weight in Pounds	Berries Per Cup	Field Weight in Pounds	Field Weight in Pounds
1	103.88	102	14.75	112	141.75	87	100.00	68.25
2	92.00	104	11.50	105	179.63	81	224.38	18.50
3	90.00	101	10.13	119	184.38	86	303.13	99.50
4	86.63	104	15.98	105	145.63	84	320.50	80.00
5	104.06	102	16.00	112	223.38	82	191.13	104.50
6	77.25	105	10.38	116	116.38	79	129.63	71.75
7	117.63	104	9.88	118	181.38	79	163.25	124.75
8	99.81	104	18.50	112	233.63	85	128.38	46.25
9	177.75	96	20.25	110	153.13	81	100.00	61.50
10	78.63	96	20.38	117	155.50	82	165.75	139.00
11	140.94	104	10.13	118	130.25	81	122.38	76.50
12	93.63	98	25.63	112	208.38	83	206.75	64.50
13	204.75	105	13.13	115	135.75	83	206.63	116.00
14	99.38	105	28.13	119	138.13	82	203.50	45.00
15	206.38	104	24.25	106	141.75	80	130.38	107.75
16	120.25	105	78.00	105	217.50	83	388.50	199.25
17	177.00	105	68.75	107	182.88	82	187.00	150.75
18	74.13	106	71.75	106	206.75	81	237.25	179.00
19	81.63	105	64.00	108	248.00	87	285.50	264.25
20	69.50	107	55.00	102	246.75	83	310.50	238.50
21	104.75	108	80.50	106	200.50	85	213.38	282.25
22	59.50	104	73.00	107	194.75	81	327.75	256.25
23	116.25	106	62.38	106	272.88	83	396.63	219.75
24	72.50	106	85.63	115	217.63	82	285.00	199.25
25	150.88	108	249.00	114	181.75	88	228.50	179.75
26	71.38	105	213.75	114	227.75	84	330.75	78.50
27	188.25	102	171.75	104	126.25	84	165.00	48.25
28	90.13	104	226.88	104	200.00	83	247.13	26.75
29	139.38	105	213.88	100	137.25	81	104.88	74.00
30	113.13	107	136.25	100	225.75	83	211.50	154.00
31	132.25	101	149.63	101	146.75	79	98.50	67.75
32	63.88	105	182.38	98	119.25	84	188.63	146.50
33	51.63	106	121.13	101	127.25	71	288.63	208.75
34	55.88	105	112.13	108	184.00	80	309.88	210.50
35	98.13	106	*......	...	203.75	81	265.13	109.75
36	82.63	109	......	...	160.50	84	436.13	140.00
37	99.38	106	......	...	168.37	87	289.63	126.00
38	100.50	106	......	...	253.50	83	290.88	55.00
39	147.88	99	......	...	135.63	84	147.75	86.75
40	105.75	107	......	...	238.75	81	288.00	67.50
41	105.63	97	......	...	187.63	83	163.38	31.50
42	84.50	104	......	...	188.00	84	282.25	96.50

* No records are available for Plots B 35 to B 42.

spring of 1916, followed by rainy weather during blooming time, and a poor crop resulted on both of these bogs as a general rule. It also happens that in Series B, Plots No. 25 to 42

are located in a different bog from the one which contains Plots 1 to 24, and that the former bog bore a good crop, while the present. These factors, together with the pruning operations in 1916, will make interpretation of the figures for this season very difficult. It is hoped, however, that something may be gainel from the records, even though they were influenced by factors not under control.

Table VII records the field weights of all five series and the size tests of Series A, B and C for 1916.

A comparison of Table VII with Tables I and II shows that, due to the combination of factors previously mentioned—omission of the fertilizer treatment, pruning and unfavorable weather—on Series A and B, the yields were much lower than in 1915. On Series C there has been some reduction, but not such a noticeable one. On Series D and E, however, where no pruning was done and no other factors helped to reduce the yield, the crop was twice as large as in 1915. In 1915 Series D and E yielded 4,991.0 pounds and 2,547.0 pounds, respectively, while in 1916 the yields were 9,635.0 pounds and 5,121.0 pounds, respectfully. This seems to indicate that the vines produced the 1916 crop under more favorable conditions of growth and food supply than in 1915, and that more moderate applications of fertilizers would prove more beneficial than the amounts heretofore used in this experiment. In 1915 Series C produced 8,229 pounds, and 7,503 pounds in 1916. In 1915 Series A produced 12,549 pounds, and 4,530 pounds in 1916. The 1916 data of Series B are not complete, but enough so to show that the yield was only half as large as in 1915. As before stated, it is difficult to interpret the results for 1916 properly, but apparently the pruning has so disturbed the vines as to cause a decrease in yield. Had the fertilizer treatment merely been omitted, without the pruning, the yields would have been greater than in 1915, at least in Series B and C; but a combination of the two has so decreased the yields that even on Series C, where the crop on the whole bog was as good as last year, and where increases might have been expected if no pruning had been done, there was a decrease. It seems probable that in 1917, with the omission of the fertilizers in 1916, and the pruning in 1916, the experiment could be continued with further application of plant-food, but with some modification, however. The results of 1915 showed that the rate of application was too heavy, and should in the future be decreased.

CRANBERRY IMPROVEMENT

Improvement in the cranberry plant may be accomplished by three methods: (1) plant selection; (2) seed selection, and (3) cross-breeding.

Up to the present time, all improvement of the cranberry plant has been brought about by plant selection and propagation by cuttings. In this way, many so-called "varieties" have been developed, all more or less distinct, and yet none so individual as to be called pure. There is often as much difference in size, color and shape among berries of the same variety, as between berries of different varieties.

Very little has been done to make the standard varieties more nearly pure. Generally the grower has been too much engrossed in the other phases of cranberry culture to think of this phase. The operation is a slow one, and the length of time necessary to bring the plants to profitable bearing is so great that although it is entirely within the compass of the grower, he has not concerned himself with it. But this does not mean that there is no possibility for improvement, that the plant has reached its highest state of development. So long as variation is present, efforts to improve the strains and types should continue.

The method of seed selection is a simple one and could be used in the improvement of the cranberry as well as in the improvement of other fruits. This method, however, is less certain to produce favorable results than either plant selection or cross-breeding.

Cross-breeding, though not a new idea, has not heretofore been tried with cranberry varieties. Strictly speaking, purity of varieties should precede breeding work, but if the ideal is known, and if suitable selections can be made which will serve as parents to the ideal, then breeding may be begun with reasonable assurance of success. Selection has produced types that have many, but not all, of the qualities desired in a cranberry. By crossing these types it is hoped to produce new types that will combine the characters of the parents, and possibly produce the ideal. For instance, a cross between the "Centennial" variety, which is superior in size and flavor, but poor in color and keeping qualities and matures late, and the "Early Black" variety, which is deficient in size, but superior in color and keeping quality, and matures early, should produce a type that has all the desired characters.

As a general rule, the grower is too much concerned with other problems to conduct work of this kind, and, unfortunately,

there is no State-owned bog or cranberry station in this State, such as exists in Massachusetts and Wisconsin. For this reason, coöperation between the grower and the Experiment Station would help to remove some of the present difficulties. Recognizing the value of such coöperation, the State of New Jersey has appropriated to the Experiment Station funds for conducting research work on cranberry varieties and the improvement of these by selection and breeding.

In accordance with the purpose of the appropriation, studies have been begun, mainly at Whitebog, N. J., and these studies are to be continued indefinitely. Although the studies were begun under unfavorable conditions and progress has been somewhat retarded, nevertheless a fair start has been made. Crosses have been secured between several varieties, combining characters that might be expected to produce desirable types. It is aimed, also, to make plant and seed selections, which together with the crosses already obtained, will place the project on as extensive a basis as possible. With the funds to carry on this work, and with the coöperation of the growers, the Experiment Station hopes to make progress and ultimately to meet with results that may prove an uplift to the industry.

II

REPORT ON THE WATER SUPPLY IN THE CRANBERRY BOGS OF NEW JERSEY

Franklin O. Church

INTRODUCTION

The work of making a survey of the water supply in the cranberry bogs of New Jersey was assigned to the writer in March, 1916, and preliminary work was started at once. The results of this survey are presented herewith in the form of a general report on the subject.

SURVEY OF WATER SUPPLY

A list of water-supply questions was prepared which, with a circular letter, was sent to all members of the American Cranberry Growers' Association, the mailing list being supplied by the secretary of the association.

The questions were selected with a view to obtaining a record, in some detail, of the extent of the industry in New Jersey, the

locations of the principal bogs and, in a general way, the water-supply conditions. While valuable information was obtained by this means, the results fell short of those anticipated, for out of 94 members of the association registered as growers, only 22 furnished any part of the information desired. Data were later obtained from 7 other growers. From an examination of the data received, a good idea of the extent, and, so far as hydraulic conditions are concerned, the condition of the industry may be obtained.

In this State approximately 10,000 acres are under cultivation in cranberry bogs, aside from extensive areas devoted to reservoirs and other lands held in connection with cranberry bogs for various purposes. On the whole the material obtained does not yield itself readily to summarization but portions of it may be presented briefly. A copy of the questions submitted and a brief summary of the answers to the more general questions follow:

To Members American Cranberry Growers' Association:

It is proposed to make a survey of the Water Supply in the Cranberry Bogs of New Jersey.

The enclosed questions are sent to you in order that as much data as possible may be collected preliminary to, and as a basis for, the actual field work of the survey.

Complete and accurate answers to these questions will be of value to the Station and of great assistance in this survey. Field work will be started as soon as weather conditions permit, so promptness in attention to this matter will be greatly appreciated.

Very truly yours,

F. O. CHURCH,
In charge of the Survey.

Address:
Alumni Club House,
New Brunswick, N. J.

Survey of the Water Supply in the Cranberry Bogs of New Jersey

PRELIMINARY DATA

A. GENERAL INFORMATION: Owner, post office, location of bogs, etc.

B. 1. Number of acres under cultivation:
   2. Number of separate bogs:
   3. Approximate acreage of principal bogs:
   4. Age and history of each bog:

C. 1. Streams flowing into and adjacent to the property:
      Number of streams:
      Names:
   2. Number of reservoirs maintained:
   3. Approximate difference in head of reservoirs:
   4. Approximate area covered by each reservoir:
   5. Nature of soil and vegetation over flooded areas:
   6. Maximum depth of each reservoir:
   7. Is available supply of water sufficient for needs at all seasons:
      1. Without storage:
      2. With storage:

8. At what time of year have recent shortages occurred and what has been their duration?
9. Is the entire supply of water available to all parts of the bogs without pumping?
10. Have you satisfactory control over the water supply?
11. Have you suffered financial loss because of insufficient water supply or lack of proper facilities for handling the water effectively?
12. When has this occurred within recent years and what was the immediate cause of the damage to the crop in each instance?
13. What is the allowable length of time for flooding the bogs (hours)?
14. What is the allowable length of time for draining the bogs (hours)?

D. 1. Do you maintain a pumping plant for irrigation purposes?
Number of pumps:
Maker:
Type:
Size (suction):
Capacity:
Total head pumped against:
How driven:
Horse power of engine or motor:
2. Is the plant satisfactory in capacity and operation?
3. At what times during the year is it operated?

E. Reservoir Embankments:
1. How constructed?
Material of core wall:
Thickness of core wall:
Material of embankment:
Width of embankment at top:
Maximum height:
Width at base of highest section:
Nature of slope protection:
1. Water side:
2. Bog side:
2. Is seeping through reservoir embankment utilized for irrigation of bogs?

F. Canals and Ditches:
1. Approximate dimensions of main canals:
Give width at top and bottom, and average depth:
2. Average depth of water in main canals:
3. Dimensions of lateral ditches: Width: Depth:
Distance apart:
4. Average width and depth of small drainage ditches:
5. How often are ditches cleaned?
6. Are drainage conditions on the bogs satisfactory?

G. 1. Can you furnish data on the cost of constructing and maintaining reservoir embankments, outlet works, gates, flumes, canals, ditches, pumping plants, etc.?
2. Have you any local data available such as maps, level notes, rainfall records, stream flow measurements, temperature charts, evaporation records, etc.?
Please describe any that you may have.
3. General Suggestions:

The number of acres in the bogs of the individual growers ranged from 10 or 12 acres for the smallest growers, up to 600 acres for the most extensive growers. The 29 growers replying to the questions represent a total acreage of approximately 4,550 acres in bogs. This does not include reservoir sites or unim-

proved lands. The records cover over 400 separate bogs varying in size from 5 acres to 100 acres each.

Very little information was obtained on the subject of age and history of the bogs. For the extensive plants a history of the bogs would be voluminous and few of the growers attempted to answer that question. In age the bogs range from 1 to 50 years, a very large percentage of the bogs being comparatively old. Some of the old bogs have been renewed in whole or in part, but there has been very little increase within recent years in the acreage devoted to the industry. In his report to the Forty-seventh Annual Convention of the American Cranberry Growers' Association, the secretary of that body states that there has been no increase in acreage in New Jersey during the past 20 years; the acreage developed by new enterprises and reclamation only equalling that of abandoned bogs.

The reservoirs vary in size from 10 to 200 acres; the average size is about 25 to 30 acres. Water is rarely impounded to depths of more than 5 or 6 feet. Only 13 growers report having sufficient water supply with their present systems. Twelve growers report a serious shortage of water, and of this number 5 maintain no reservoirs. On the subject of shortage in water supply the data furnished were meagre. Many growers find it extremely difficult to secure enough water for the June reflow and others report shortage during the summer months and for frost protection in the fall. Six growers state that they cannot flood all their bogs from the present reservoir systems by gravity, and to do so would have to install pumps. Fourteen growers have satisfactory mechanical control over their water supplies, 9 have not. The inability to handle the available water in a satisfactory and efficient manner is in most cases due to the inadequacy of gates and ditches. Fifteen growers report that they have suffered financial losses due to the above-mentioned causes.

Such losses have occurred, almost without exception, in May and June, and the immediate cause of the damage has been fireworm or frost.

There is a wide variety of practice in the matter of flooding and draining the bogs, the time required for these operations depending on the amount of water available and the capacity of the system for handling it.

SOURCES OF SUPPLY

There are two principal sources of water supply available to the cranberry bogs in southern New Jersey, the numerous small streams and the extensive cedar swamps.

The streams all have a strong family likeness owing to a marked similarity in the topography and geology of their watersheds. The general character of the soil is such that these streams yield a much greater flow, for a given depletion of ground water, than the streams of the northern part of the State. They are characterized by an unusually well sustained dry weather flow and a corresponding freedom from sudden floods. This steadiness and dependability of flow is accounted for by the gentle topography, the large percentage of the drainage areas still in forest and the extensive swamp storage. These conditions make the streams an especially good source of supply for cranberry bogs; for on account of the flatness of the country, storage to any considerable depth is impossible, and, consequently, great areas are required for reservoirs, with attendant excessive seepage and evaporation losses.

Fairly complete records are available of the rainfall at a large number of stations throughout southern New Jersey, and while local variations of more or less magnitude always occur, the average annual precipitation for this section, based on records covering the past 20 years, has been approximately 47 inches. Temperature records show the mean annual temperature for the same areas to be 52° to 55° F. for the interior and from 52° to 53.6° F. for the coast.

For these conditions of rainfall and temperature, about 27 inches of the total rainfall is lost by evaporation during the year, thus leaving 20 inches to maintain ground water, the flow of streams and the growth of vegetation. The Report of the State Geologist for 1894 on the water supply of New Jersey offers very valuable information on the streams of the southern portion of the State. Records of rainfall, stream flow, temperature and evaporation are presented and processes set forth by which the water supply available at any particular location may be computed with a fair degree of accuracy, by taking proper account of the controlling conditions.

The demands on a cranberry bog water supply system may be described briefly in the following manner:

The first demand in the course of a year is for the winter flooding, which is ordinarily accomplished during January. Considerable time is allowed for obtaining a full head on the bog, the only necessary condition being that they are thoroughly flooded before the weather becomes so severe as to kill the plants. The water is brought well up over the highest plants, if possible, and is then held there until the weather moderates in the spring. This water is ordinarily drawn off during May.

The vines at this time are very susceptible to damage by frost and in case of danger, the warm water is let down from the reservoirs and fills the ditches or is brought up around the vines. This causes the formation of a blanket of mist over the bog which effectively protects the vines from injury.

The next demand on the water supply is for the June reflow. This consists of flooding the bogs until the tips of the highest vines are covered, and then rapidly withdrawing the water. The purpose of this reflow is to free the bogs from destructive insect pests and the successful accomplishment of the reflow is the real test of a water-supply system.

Several severe frosts in rapid succession may make serious demands upon the storage reservoirs and leave an insufficient supply for accomplishing the reflow successfully.

The practice is to flood the bogs in blocks of two or three, depending on their size and relative location and elevation, using the water from the first block to flood the next block, and so on. The quantity of water required is large and there is considerable loss to be made up due to leakage through gates and seepage through embankments. The vines are in such condition at this period that the length of time that they can be submerged, without resulting injury, is strictly limited. As to the allowable duration of submergence at this time opinions differ among the various growers, but the desirable range is from 24 to 72 hours. Few growers can accomplish the reflow in this time and many are making an effort to reduce the length of time required. Thus not only is the quantity of water an important item, but gates and ditches must be of adequate size and properly located, in order to get the water on and get it off again within the permissible length of time. From the information furnished it is apparent that many growers find it extremely difficult to reflow successfully with their present water-supply systems. After the June reflow the demands for water during the remainder of the growing season are comparatively light. Water for irrigation must be supplied to keep the vines in a healthy condition, but the quantity is ordinarily small and may be supplied by the natural summer flow of the stream or swamp supplying the system.

In September, when the berries are ripe and about to be picked, further occasional flooding for frost protection may be necessary. This must be accomplished on short notice and several frosts may occur in succession. Several growers have reported losses at this time of year, due either to lack of warning of the approaching frost, or inability to flood their bogs in time to prevent injury when frost was anticipated.

When the fruit has been gathered there are no further operations of the water system until the gates at the low bogs are closed and the accumulation of water for the winter flooding is begun. The successful management of a cranberry bog water supply in accomplishing these important protective floodings without excessive waste of water and without causing damage to the vines or fruit requires good judgment and thorough familiarity with the supply system, which can be attained only through long experience and study.

The fact that only comparatively low heads are obtained in the storage reservoirs, and that all these operations of flooding from reservoir to bog, or from one series of bogs to the next series, are accomplished under constantly falling heads, make the matter of size and design of gates and capacity of ditches a vital one. Cases have been noted where growers have suffered loss, time after time, because of inadequate mechanical facilities for handling the water.

The tendency is to make gates too small and ditches of insufficient capacity, when at a slightly increased cost of construction, fully satisfactory results might be obtained.

The conditions on the individual cranberry bogs are so varied that it would be impossible to devise any standard water-supply system that could be successfully applied to each. It might be stated that no two bogs demand exactly the same treatment, and methods which would operate successfully on one bog would absolutely ruin another bog. Thus since the supply system must be designed to meet the requirements of the method of treatment demanded by the peculiar conditions of the bog, it is seen that absolute standardization is impracticable.

The most plausible lines of activity, then, in the investigation of cranberry water-supply systems, would include the improvement of details and the design of systems for new developments, and the correction of faults in the old systems where a change seems justified.

Many of the cranberry bogs in the State were visited during the winter and the water-supply systems carefully inspected. It was noted that the extensive plants might be roughly divided into two types of development.

The first and more general type is that in which the bogs are constructed in succession in the valley of a small stream by clearing away the trees and stumps and constructing transverse dams at intervals. The dams extend from the upland on one side, out across the stream and to the upland on the opposite side. Gates are provided to accommodate and control the flow of the stream

and at the head of the development storage is usually provided to permit of quick flooding in case of necessity. It is the usual practice to allow the stream to follow its natural course down through the middle of the bogs, although some of the meandering streams have been straightened by cut-offs and improved by deepening. Such improvements reduce the amount of waste land and insure a more effective handling of the water. Lateral ditches are dug at intervals, their location, size and frequency depending on local conditions and being determined by the judgment of the operator.

In the majority of the cases noted the single channel of the stream was the only main channel provided and served for both drainage and irrigation. A great improvement on this system is accomplished by constructing channels down along each side of the bogs, next to the upland, and diverting the water at the reservoir so that it reaches the bogs through these channels and is distributed by means of lateral ditches running from the sides of the stream in the middle. In this way the natural channel of the stream simply serves as a drainage ditch to carry away excess water and maintain circulation.

An excellent example of this type of irrigation system was noted on the bogs of Mr. George H. Holman, near Lakehurst, N. J. Here a series of four bogs, about 45 acres in all, has been developed along a stream supplying an abundance of water. A storage reservoir covering approximately 40 acres is provided at the head of the bogs. The ditches are arranged as shown in figure 1. The advantages of this system are apparent. Water conditions on these bogs are highly satisfactory and the vines were in a very healthy condition and bearing abundantly. The small lateral ditches shown are spaced two rods apart.

On bogs where the slopes are considerable and where the character of the soil is varied, however, this system falls short of the ideal in that it does not readily permit giving special treatment to any portions of the bog that may plainly require either more or less water than the average.

These difficulties are effectively overcome in a new and efficient system which has been lately installed by Joseph J. White, Inc., on some bogs of this type recently developed. Irrigating water is supplied from a reservoir at the head of the development through two irrigating ditches located along the upland edges of the bog. From these main irrigating ditches, laterals 2 feet wide and 1 foot deep are dug at intervals of 10 rods, running straight across the bog, to the natural stream near the

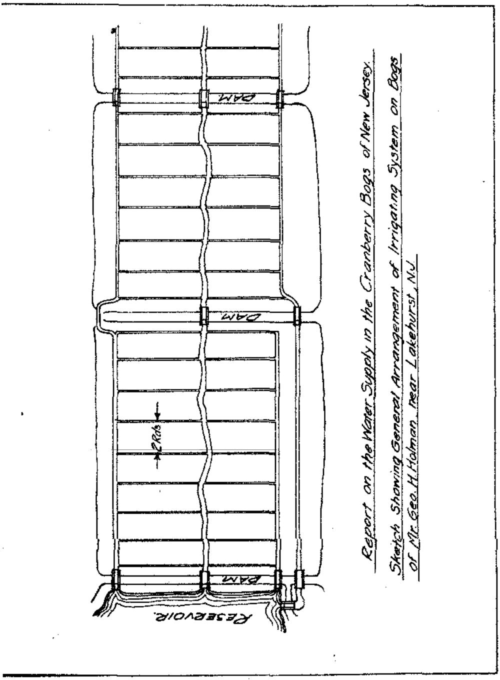

Fig. 1. **Irrigating system on bogs of Geo. H. Holman, Lakehurst, N. J.**

middle. At the point where each lateral taps the irrigating ditch a small trunk (about 3 x 3 inches inside) of 2-inch plank and provided with a simple adjustable gate, is set, and at the other end of each lateral just before it enters the stream, a small adjustable check is provided. Thus by means of the small trunks or gates the amount of water running down each ditch may be controlled, and by adjusting the checks water may be maintained at exactly the elevation considered most beneficial to the immediate area served by the lateral. The layout of this system is shown in figure 2.

In the other general type of bog layout, no standard arrangement can be noted. The bogs may occupy a large area and be blocked out by dams into convenient sizes and shapes. They may be far removed from the source of water supply and the water conducted to the various series of bogs by a system of main canals from the storage reservoirs. Water may be supplied to the reservoir by diversion from a stream quite distant and one reservoir may serve several series of bogs.

This arrangement of bogs requires the construction of far more extensive dams than where the narrow valley of a stream is utilized, for ordinarily each bog is entirely surrounded by artificial embankments. In each bog one or two main longitudinal ditches are provided as well as a ditch 3 to 4 feet wide entirely around the bog just inside the embankment. Laterals are provided as is considered necessary from observation of the bog.

This system does not permit of very close adjustment of water conditions, aside from such as may be accomplished by an occasional check or brake to hold water back in the upper reaches of main ditches.

In the inspection trips, particular attention was paid to the type of structures in use in connection with the water-supply system. Some of the more important of these will be discussed in detail.

The dams and embankments for both reservoirs and bogs are of earthwork practically without exception. The usual practice in constructing these dams is to clear the surface of the ground along the site, removing brush and vegetation. A trench about 2 feet wide is then dug along the center line of the embankment for its entire length. This trench is carried down through the surface stratum of muck or peat to good sand bottom and all buried stumps or logs encountered are carefully removed. The material used for the construction of the dam is clean sand of the best quality obtainable convenient to the work. Fortu-

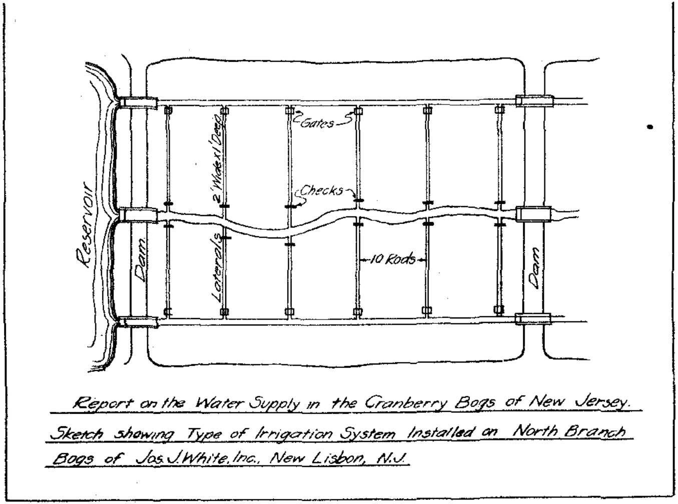

Fig. 2. Irrigation system on bogs of Jos. J. White, Inc., New Lisbon, N. J.

nately, throughout this cranberry growing region there is an abundance of high-grade sand admirably suited to this purpose. The trench is first filled with sand and then the construction of the embankment proper is begun. According to the best practice the top width at completion is about 12 feet, this being sufficient to provide a safe roadway. Side slopes vary somewhat, but will average close to 1.1 horizontal to 1.0 vertical. Slopes are protected by turf cuttings carefully placed by hand in single layers against each slope, as shown in figure 3. These sods are scalped from the surface of the bog on either side of the dam if the material is considered suitable; otherwise cuttings are taken from the nearest satisfactory area and hauled to the site. Thus a compact protective covering averaging from 15 to 18 inches in horizontal thickness is provided to hold the material in position and prevent damage from the action of the water and strong winds. Weeds and brush grow rapidly on these turfed slopes and the roots bind the cuttings into a tough and almost homogeneous mass.

As soon as the embankment is completed the water should be raised against it to the highest obtainable head and then allowed to recede slowly. This compacts the material firmly. No traffic should be allowed to pass over the dam for some time after its completion, and careful watch should be kept to detect any small leaks that may develop and make repairs before serious damage is caused. Very small dams are sometimes constructed without turfing on the lower face and a natural growth of brush and weeds is allowed to spring up here, the roots penetrating the material and tending to hold it in place. This practice is advisable only in the case of very low dams not designed to serve as roadways.

Water is rarely impounded to depths greater than 5 feet, and for these low heads this type of construction is entirely satisfactory. Materials well suited to the purpose are usually conveniently available in large quantities.

In the case of very large reservoirs or bogs, waves of considerable force may be kicked up by a stiff wind and their action on the face of dams makes some special slope protection necessary. One method of providing this protection is to drive light piles at intervals just above the foot of the slope and pack brush in between the piles and the slope. Another method is to use rough slabs driven close together flat against the face of the dam. These slabs take the force of the waves and retain any material that may be loosened from the slope of the dam. The majority of the dams inspected were of substantial construction

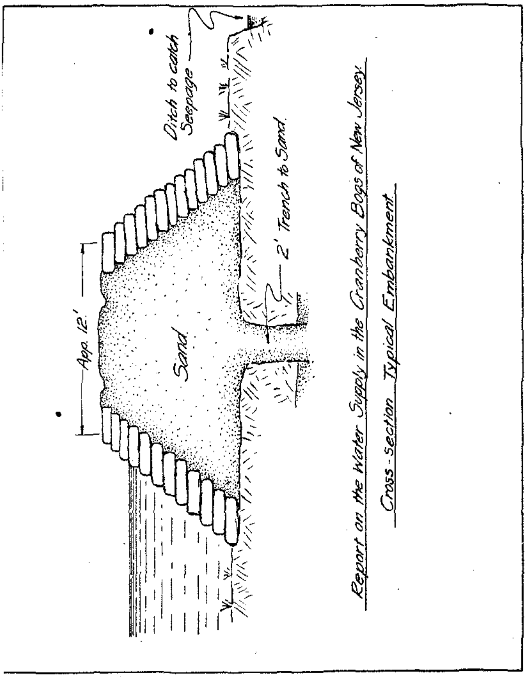

Fig. 3. Cross-section of typical embankment on cranberry bog.

and well maintained. Very few failures have occurred where the work of construction was carefully performed. It was noted, however, in many cases that no adequate spillway had been provided to carry off any excessive flood flows that might occur when the reservoir was full. Provision for such a condition should be part of the design of every dam, especially those of lightly compacted earthwork. Materials are not economically available for providing the dams with an impervious cove wall, hence the seepage losses from reservoirs are large. A ditch is usually provided running parallel to the dam a short distance from its lower toe to catch this seepage water and conduct it to the bogs for irrigation purposes.

In the matter of canals and ditches it can hardly be said that any standard practice exists. Conditions on the different bogs are so varied that no one standard system would be suitable to all of them. For the main channels of bogs of the general type first described, the natural course of the stream is commonly utilized. In some cases this channel has been improved by deepening and straightening, while in other cases it is simply cleaned out when it becomes clogged. For bogs not lying across a stream, one or more main longitudinal ditches are dug, the number depending on the width of the bog. These ditches are usually about 5 to 8 feet in width and about 2 feet in depth, depending on the slope available and the amount of water to be handled. The dimensions and frequency of the small lateral ditches is still more varied and must be determined by observation and knowledge of each individual bog. They are ordinarily 18 to 24 inches wide and from 12 to 18 inches deep. The spacing varies from 2 to 10 rods apart. The matter of properly locating these small ditches and keeping them open is a most important one, but is sadly neglected by many growers. For effective operation ditches should be cleaned every year.

GATES AND TRUNKS

Although there is a wide variety of gates and trunks in use in this State, there are certain types which have proven generally satisfactory and have been largely adopted. These may be divided into two distinct classes, the open flume and the closed trunk types. All gates must be provided with cut-off walls of sheet piling to prevent the water from leaking through the embankment around the structure and eventually causing the gate to wash out. There may be one or two rows of sheet piling as is considered necessary, depending on the importance of the structure and the heads to be resisted.

Many of the older gates are of the open-flume type. This sort of gate is especially suited to bogs lying across a stream where the gates must accommodate the entire flow of the stream and occasional flood flows. While most of the gates of this type are comparatively old, some splendid examples have been recently constructed, in which the design has been improved and greater effectiveness secured.

In the trunk type of gate the principal variations were noted in the design of receivers and outlet ends and in the manner of setting the trunks. Since timber subjected to alternate wetting and drying decays rapidly, trunks should be set so that they are constantly submerged and the sills at receiver and outlet ends should be higher than the top deck of the trunk. Thus the buried portion of the trunk will remain full of water regardless of the water-level in the ditches. The first cost of such construction will be somewhat higher than if the trunk were not set so low, but only by this means can the perseverance of the structure be assured. In constructing the receivers also, similar considerations should be borne in mind. Comparatively few of the gates observed were built with the receivers free from the embankments and surrounded by water. Where the back of the receiver is against the face of the embankment it is subject to rapid decay. The correct and incorrect methods of installing gates of this type are shown in figure 4. The sketch also shows the method of constructing the outlet with a shore uptake. This serves the purpose of destroying the velocity of the water at exit when the gate is discharged at high rate, thus preventing the channel from being badly scoured, and at the same time it holds the trunk full of water when the water drops low in the lower ditch.

The determination of size of gate required for a given bog is largely a matter of judgment. Wide variations in the areas of the bogs, irregularities in surface elevations and the different types of structure adopted by different growers, make accurate computation out of the question.

It is of greater importance that the gates be of ample size in order to permit the accomplishment of the June reflow and the occasional floodings for frost in the shortest time possible. While the majority of the gates inspected were of sufficient size, many, especially among the older structures, were entirely inadequate.

Creosoted lumber has been recently adopted by some growers for gates of the open-flume type. In these gates it is impossible to keep the timber submerged and the treatment of the material

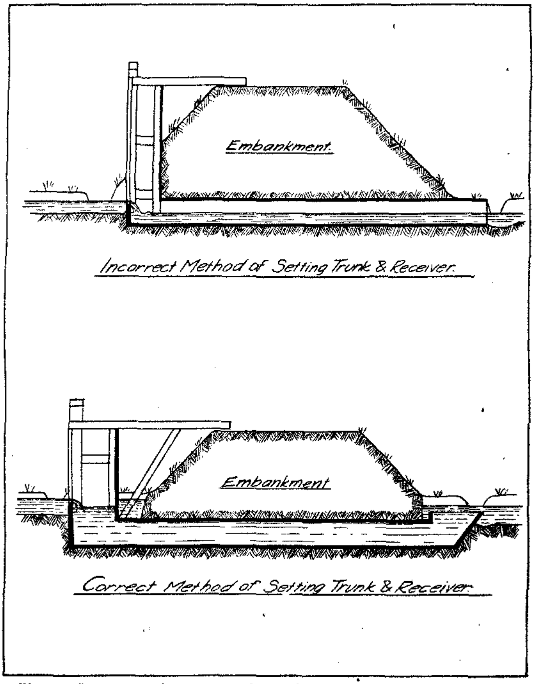

Fig. 4. Correct and incorrect methods of installing gates on cranberry bog.

may be expected to increase the life of the structure considerably.

Brakes or checks are located at intervals in ditches having comparatively steep slopes, where it is desirable to hold the water back in the upper reaches and reduce the flow. These are unusually simple arrangements, consisting of a shallow flume with a short cut-off wall of sheet piling and provided with guides for holding boards across the stream.

There are numerous other small structures in use where unusual conditions require, but those described include all that may be considered standard to the water-works systems on the bogs.

There are but two pumping plants at present installed in this State for cranberry irrigation and flooding.

The plant on the property of Joseph J. White, Inc., at Whitesbog, N. J., was erected in 1915, and has been operated two seasons. The pump is installed to raise water from a lower abundant source of supply to higher reservoirs fed ordinarily by a less dependable supply. The water thus raised is then available to all parts of the bogs by gravity. The pump is operated continuously during the June reflow and has provided sufficient water to accomplish this reflow successfully, while, previous to its installation, satisfactory reflowing of the higher bogs was impossible, or at least dependent on unusual water conditions.

The plant consists of a single unit, a 15-inch specially designed, double-suction, split-casing centrifugal pump, with a capacity under normal operating conditions, of about 6,000 gallons per minute. The pump is belt driven by a 40-horse-power gasoline engine. Suction and discharge lines are of 20-inch cast-iron pipe. This plant was tested while operating for the June reflow in 1916, and proved to be giving satisfactory results. The plant was designed by Mr. F. S. Chambers and erected under his supervision. Figure 5 shows the general arrangement. The owners state that the plant has proved a good investment, insuring, as it does, sufficient water for the important June reflow and putting an end to frequent heavy losses suffered in previous years.

The other pumping plant of which the Station has record is on the property of Mr. A. J. Rider. It consists of a 4-inch centrifugal pump with a capacity of approximately 300 gallons per minutes, driven by a 3½-horse-power gasoline engine and is satisfactory in capacity and operation. This plant is operated when drought occurs in summer.

There are comparatively few cases in New Jersey where a pumping plant for cranberry water supply would be considered

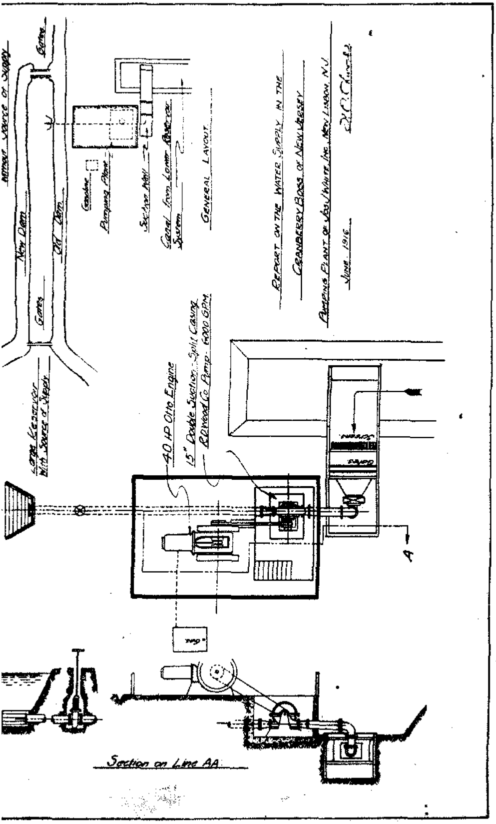

Fig. 5. Pumping plant on cranberry bog of Jos. J. White, Inc., New Lisbon, N. J.

a good investment. But if any growers contemplate installing a plant the writer cannot urge too strongly the wisdom of selecting a high-grade pump designed for the special conditions of low head water under which it is to operate. The higher cost of a good pump will be more than counterbalanced by the saving in the cost of the engine required to run it and in subsequent economy of operation.

The ordinary stock centrifugal pump is designed to operate under much higher heads than those prevailing in cranberry work, and hence these pumps will not give efficient service when used for this purpose. Consequently, for the delivery of a required quantity of water against a given head, a poorly selected pump may require an engine of more than twice the horse-power that would be required by a specially designed pump doing the same work. No pump should be purchased before it has been thoroughly tested under conditions approaching as closely as possible those under which it will be operated. Where tests have been made over a wide range of operating conditions and characteristic curves for the pump plotted, examination of the curves will show what may be expected of the pump under the conditions which will exist in service.

During the year the cranberry bogs on Cape Cod were visited, and in company with Dr. Henry J. Franklin, director of the Cranberry Sub-Station of the Massachusetts Agricultural Experiment Station, the writer inspected several cranberry water-supply systems in the vicinity of East Wareham, Mass.

It was noted that the Cape Cod bogs are smaller and much more carefully levelled than is the practice in New Jersey, and these facts have an important bearing on the problem of water supply. Sanding is carried on extensively. Under the more favorable conditions thus obtained it is practical to bring the water-supply systems to a high state of perfection.

One of the most striking features of these systems is the almost universal use of concrete structures. The wooden gates previously used are being rapidly replaced by concrete. Simple and efficient designs have been developed for the standard structures. They are permanent and require no repairs, as well as being of attractive appearance. The adaptability of this concrete construction to New Jersey bogs is considered questionable by many growers. For satisfactory results a firm foundation is essential and this might be difficult and expensive to obtain in most instances. But where the foundation is available at reasonable cost, the advantages of the concrete are apparent. This is particularly true in the case of gates of the open-flume type.

The concrete gates on the Cape are constructed in both the open flume and the trunk types and light reinforced concrete slabs are placed to form a bridge where such is required.

All the gates noted were of very generous size and gates of similar proportions on some of the New Jersey bogs would greatly facilitate flooding operations. The first cost of a concrete structure is considerably higher than that of a wooden one, but the advantages attaching to the former might in many cases counter-balance the difference in cost.

Among other interesting features noted were a steel flume to carry a water supply across a deep ravine and earthwork dams provided with concrete spillways and covewalls of concrete or creosoted sheet piling.

Several cases were noted where growers pumped practically all the water they used and in other cases pumping plants were installed simply as insurance against a shortage of water, never being used under ordinary conditions. The area served by some of these plants was as small as 12½ acres, and 25-acre plants are common.

Figure 6 is a sketch of the pumping plant at the Cranberry Sub-Station at East Wareham. The pump consists of a submerged 32-inch 3-blade cast-iron propeller mounted vertically in a rectangular sheathed well and revolving in a circular opening in a horizontal deck. Little clearance is allowed between the periphery of the propeller and the opening in the deck. Water enters at one side below the propeller and is forced up above the deck and flows out on the other side into the irrigating ditch. The plants noted were belt-driven by gasoline engines. No pumps of this type have been installed in the New Jersey bogs. These pumps are practical for handling water through heads up to 8 or 10 feet, although in the case of the plants noted the lift averaged about 3 to 4 feet. They are low in first cost and of exceedingly simple construction. It is doubtful, however, if these pumps can be made to operate at anywhere near the efficiency of a good centrifugal pump designed especially for lowheads.

EXPERIMENTAL WORK AT WHITESBOG, N. J.

Some experimental work has been started at Whitesbog, N. J., having for its purpose the study of ground-water conditions on cranberry bogs and the determination of the elevation of water-table conducive to best results.

It was thought that by means of observation wells distributed over a given area, a close record might be kept of the contour of

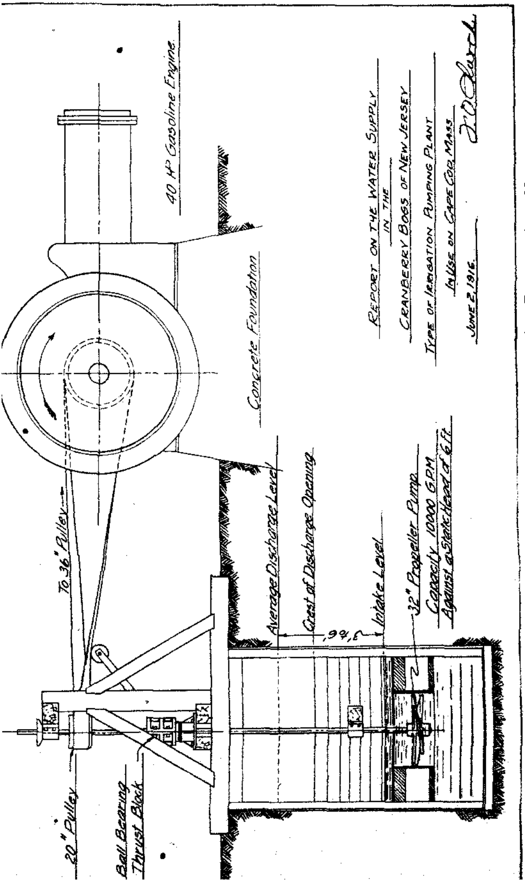

Fig. 6. Diagram of pumping plant at the Cranberry Sub-station, East Wareham, Mass.

of the embankment cut-off trench and perhaps some outcroppings of sand within the reservoir the water has easy access to the sand which underlies the mud bottom of the bog. The impervious layer of mud prevents this water from freely escaping to the surface, and consequently it is under pressure in the stratum of sand. This pressure diminishes rapidly as the distance from the reservoir increases, due to friction losses in passing through the voids in the sand. When the wells are reached the water is still under some slight pressure. It rises part way to the surface through the layer of mud and stands at the point where the rate of supply just equals the rate of seepage away to the ditches through the soil. The water inside the pipes is subject to the same pressure, but cannot escape to the ditches, hence it rises in the pipe until the pressure is equalized and stands at level.

Some interesting data have already been obtained from these experiments, and, should results seem to make it worth while, more extensive work of the same nature will be carried on in other locations.

It has become very evident that some of the cranberry-bog soils do not respond in a satisfactory manner to the ordinary methods of drainage. Several cases have been noted where small areas entirely surrounded by ditches were still too wet, although the distance from any point to the nearest ditch might be but a rod or two.

It would seem that where a bog consists of a dense soil, underlaid by sand-bearing water under pressure, due to a nearby reservoir, the water would have a tendency to rise to the surface of the bog at the points of least resistance. The variations in the structure of the bog soil and the fact that it contains buried logs and stumps cause the occurrence of occasional weak spots, and at these points the water will be forced up in greatest quantity and percolate from these points out through the soil in all directions. At such points the water would stand at a higher elevation than in the other portion of the bog. These points could be determined by water-table observations and tapped by ditches. Ditches so located would intercept the excess supply of water at its source and conduct it away, thus preventing injury to the area. Some investigation has been carried on along these lines but not enough to justify definite conclusions. It is felt that further experiments might yield results that would be of value.

There is within the State much land that is suitable for development as cranberry bogs. In view of the fact that there has been no pronounced expansion of the industry within the past few years and that there do not seem to be any immediate pros-

pects of important developments in the future, no special investigations of such lands have been made by the Station.

The writer is convinced that there is room for improvement in the water-supply systems in the cranberry bogs, and that continued investigation and study of drainage and irrigation problems will yield results that will be of practical value. This conviction is strengthened by expressions of opinion from some of the most prominent and progressive growers in the State. Those growers who have paid special attention to this phase of the industry claim for it prime importance.

The writer wishes to express his appreciation of the helpful coöperation of the growers with whom he has come in contact in the course of this work

REPORT OF THE DEPARTMENT OF SOIL CHEMISTRY AND BACTERIOLOGY

Department of Soil Chemistry and Bacteriology

Jacob G. Lipman, Ph.D., *Soil Chemist and Bacteriologist.*
Augustine W. Blair, A.M., *Associate Soil Chemist.*
*Harry C. McLean, M.Sc., *Chemist and Bacteriologist, Soil Research.*
Louis K. Wilkins, B.Sc., *Field and Laboratory Assistant.*
†Selman A. Waksman, M.Sc., *Research Assistant.*
Roland E. Curtis, B.Sc., *Research Assistant.*
‡Joseph R. Neller, M.Sc., *Research Assistant.*

* On State Station.
† Resigned August 1, 1916.
‡ Appointed September 1, 1916.

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Report of the Department of Soil Chemistry and Bacteriology

Jacob G. Lipman
Augustine W. Blair

I

THE INFLUENCE OF THE MECHANICAL COMPOSITION OF THE SOIL ON THE AVAILABILITY OF NITRATE OF SODA AND DRIED BLOOD

This is a continuation of the work that was begun in the spring of 1911, the results having been published in the annual reports for the respective years since that time. The work has been carried out in cylinders of the type that has been in use at this Station for a number of years.[1] The soil used in the cylinders was the typical red shale that had not been under cultivation. After screening to remove the stones, this was mixed with coarse white sand in varying proportions as indicated in figure 1. It will be noted that the cylinders are arranged in ten groups, or series, of six each; numbers 1 and 2 in each series being checks, 3 and 4 receiving 10 gm. of nitrate of soda and 5 and 6 an equivalent amount of dried blood. The cylinders of Series A contain the shale soil, Series B the shale soil with 10 per cent of sand, and so on to series J, which is entirely coarse white sand. Each cylinder receives annually 20 gm. of acid phosphate, 5 gm. each of potassium sulfate and muriate, 38 gm. of precipitated chalk (or ground limestone) and 2 gm. of magnesium carbonate. Two crops have been grown each year—a main crop, barley, and a residual crop, usually buckwheat.

In this experiment it is desired to ascertain the relative availability of nitrogen from the two sources under the varying mechanical conditions.

Main Crop—Barley, 1916

The cylinders remained bare during the winter of 1915–1916 and were prepared and seeded to barley on April 20. The seed germinated well and the plants grew nicely, the crop being about the best that has been grown on these cylinders. It was harvested July 14 and the crops from each cylinder dried, weighed and prepared for analysis. The dry weights, together with other analytical data, are reported in Table I.

[1] Voorhees, E. B., and Lipman, J. G. Investigations relative to the use of nitrogenous materials, 1898–1907. N. J. Agri. Exp. Sta. Bul. 221, 52 pp., 1909.

Plan of Experiment.

Series.	Arrangement of Cylinders.			Soil.	Treatment.
A, ...	1	2	3	Shale soil, ..	1, 2, nothing; 3, 4, 10 gm. nitrate of soda; 5, 6, 13.24 gm. dried blood.
	4	5	6		
B, ...	1	2	3	10% sand, ...	"
	4	5	6		
C, ...	1	2	3	20% "	"
	4	5	6		
D, ...	1	2	3	30% "	"
	4	5	6		
E, ...	1	2	3	40% "	"
	4	5	6		
F, ...	1	2	3	50% "	"
	4	5	6		
G, ...	1	2	3	70% "	"
	4	5	6		
H, ...	1	2	3	80% "	"
	4	5	6		
I, ...	1	2	3	90% "	"
	4	5	6		
J, ...	1	2	3	100% "	"
	4	5	6		

Fig. 1.—Arrangement of cylinders, showing soil dilutions and fertilizer treatment.

Table I

First Crop—Barley, 1916

SERIES		Nitrogen Applied, gm.	Dry Matter, gm. Per Cylinder	Dry Matter, gm. Average	Per Cent Nitrogen	Nitrogen, gm. Per Cylinder	Nitrogen, gm. Average	Nitrogen, gm. Increase Over Check	Per Cent Nitrogen Recovered	Relative Availability
A	1, ...	....	33.0	....	1.060	0.350	....	....	....	....
	2, ...	Nothing	34.9	33.95	1.076	0.376	0.363	....	....	....
	3, ...	....	139.5	....	1.067	1.488	....	....	....	....
	4, ...	1.54	151.0	145.25	1.021	1.542	1.515	1.152	74.80	100.00
	5, ...	....	121.5	....	0.958	1.164	....	....	....	....
	6, ...	1.54	113.2	117.35	0.839	0.950	1.057	0.694	45.06	60.24
B	1, ...	....	46.1	....	1.104	0.509	....	....	....	....
	2, ...	Nothing	36.3	41.20	1.113	0.404	0.457	....	....	....
	3, ...	....	152.0	....	0.885	1.345	....	....	....	....
	4, ...	1.54	139.3	145.65	0.958	1.334	1.340	0.883	57.34	100.00
	5, ...	....	112.0	....	1.031	1.155	....	....	....	....
	6, ...	1.54	112.0	112.00	1.040	1.165	1.160	0.703	45.65	79.61
C	1, ...	....	35.0	....	1.003	0.351	....	....	....	....
	2, ...	Nothing	33.0	34.00	1.104	0.364	0.358	....	....	....
	3, ...	....	129.2	....	0.949	1.226	....	....	....	....
	4, ...	1.54	127.6	128.40	0.894	1.143	1.185	0.827	53.70	100.00
	5, ...	....	107.9	....	1.131	1.220	....	....	....	....
	6, ...	1.54	114.1	111.00	.894	1.020	1.120	0.762	49.48	92.14
D	1, ...	....	27.0	....	1.195	0.323	....	....	....	....
	2, ...	Nothing	33.5	30.25	1.213	0.406	0.365	....	....	....
	3, ...	....	138.1	....	1.058	1.461	....	....	....	....
	4, ...	1.54	138.1	138.10	0.939	1.297	1.379	1.014	65.84	100.00
	5, ...	....	99.2	....	1.195	1.185	....	....	....	....
	6, ...	1.54	102.0	100.60	1.122	1.144	1.165	0.800	51.95	78.90
E	1, ...	....	28.8	....	1.277	0.368	....	....	....	....
	2, ...	Nothing	30.7	29.75	1.094	0.336	0.352	....	....	....
	3, ...	....	141.0	....	0.830	1.170	....	....	....	....
	4, ...	1.54	140.1	140.55	1.040	1.457	1.314	0.962	62.47	100.00
	5, ...	....	96.3	....	1.040	1.002	....	....	....	....
	6, ...	1.54	105.0	100.65	1.003	1.053	1.028	0.676	43.89	70.26
F	1, ...	....	33.0	....	1.286	0.424	....	....	....	....
	2, ...	Nothing	29.5	31.25	1.240	0.366	0.395	....	....	....
	3, ...	....	147.8	....	0.894	1.321	....	....	....	....
	4, ...	1.54	134.6	141.20	1.085	1.460	1.391	0.996	64.68	100.00
	5, ...	....	92.0	....	1.040	0.957	....	....	....	....
	6, ...	1.54	92.8	92.40	1.031	0.957	0.957	0.562	36.40	56.42
G	1, ...	....	21.1	....	1.286	0.271	....	....	....	....
	2, ...	Nothing	21.2	21.15	1.177	0.250	0.261	....	....	....
	3, ...	....	132.0	....	0.949	1.253	....	....	....	....
	4, ...	1.54	127.3	129.65	0.958	1.220	1.237	0.976	63.38	100.00
	5, ...	....	79.8	....	0.976	0.779	....	....	....	....
	6, ...	1.54	79.7	79.75	1.049	0.836	0.808	0.547	35.52	56.03
H	1, ...	....	20.7	....	1.195	0.247	....	....	....	....
	2, ...	Nothing	19.2	19.95	1.222	0.235	0.241	....	....	....
	3, ...	....	112.9	....	0.985	1.112	....	....	....	....
	4, ...	1.54	111.4	112.15	0.894	0.996	1.054	0.813	52.79	100.00
	5, ...	....	75.7	....	1.067	0.808	....	....	....	....
	6, ...	1.54	81.0	78.35	1.003	0.812	0.810	0.569	36.95	70.00
I	1, ...	....	11.0	....	1.094	0.120	....	....	....	....
	2, ...	Nothing	18.0	14.50	1.113	0.200	0.160	....	....	....
	3, ...	....	115.1	....	0.958	1.103	....	....	....	....
	4, ...	1.54	112.4	113.75	0.976	1.097	1.100	0.940	61.04	100.00
	5, ...	....	87.5	....	0.921	0.806	....	....	....	....
	6, ...	1.54	68.0	77.75	0.939	0.639	0.723	0.563	36.56	59.89
J	1, ...	....	16.4	....	1.058	0.174	....	....	....	....
	2, ...	Nothing	24.0	20.20	1.204	0.289	0.232	....	....	....
	3, ...	....	87.2	....	1.177	1.026	....	....	....	....
	4, ...	1.54	73.7	80.45	1.341	0.988	1.007	0.775	50.32	100.00
	5, ...	....	75.0	....	0.985	0.739	....	....	....	....
	6, ...	1.54	65.2	70.10	1.031	0.672	0.706	0.474	30.78	61.17
Ave.,	....	Check	27.62	....	1.156	0.318	....	....	....	....
	....	$NaNO_3$	127.52	....	0.993	1.252	....	....	60.64	100.00
	....	Dr. Blood	94.00	....	1.015	0.953	....	....	41.23	68.47

As in previous years, the check cylinders produced the least dry matter and the nitrate cylinders the most, the average for the entire series being, checks 27.6 gm., nitrate 127.5 gm. and dried blood 94.0 grams. The highest yield of dry matter, 145.65 gm., is found in Series B with nitrate of soda, and the yields with this material on Series A, D, E and F are only a little less. The highest yield with dried blood is 117.35 gm. on Series A, and from this there is a gradual decline, with increased percentages of sand, until a yield of 70.1 gm. is reached on Series J, which is the pure sand. The highest yield from the check cylinders is 41.2 gm., from Series B, and the lowest, 20.2 (slightly less than half the yield from Series B), from Series J. The yield of 141.2 gm. with nitrate on Series F as compared with a yield of 145.65 gm. on Series B would indicate that the loss of nitrate through leaching has not been much greater with 50 per cent than with 10 per cent of sand.

The way in which the yields with nitrate of soda have held up, even with 70, 80 and 90 per cent of sand is rather remarkable. No doubt this is to be attributed, partly, to the fact that the rains were well distributed and not excessive at any time during the growth of the crop. The barley yields are indicated by the curves in the upper part of figure 2.

PERCENTAGE OF NITROGEN IN THE DRY MATTER

It is of interest to note that the percentage of nitrogen in the dry matter from the check cylinders is higher than it is in the dry matter from the nitrate cylinders in all cases except in Series J. That is, the starved plant stores up more nitrogen, in proportion, than the healthy plant. This has been noted before, both in cylinder and pot experiments, and although a high nitrogen content for feeding materials is desirable, it should not be secured at the expense of leaf and stem growth, that is, normal plant development. This stunted growth due to a deficiency of nitrogen is very common, especially in general farming, and farmers should remember that if they would produce a maximum crop there must be present in the soil a considerable excess of available nitrogen. The average percentage of nitrogen in the crop from the check cylinders is 1.156; the average for that in the nitrate cylinders is 0.99, and for the dried blood cylinders 1.015.

TOTAL NITROGEN RECOVERED

The total nitrogen recovered in the crop is dependent upon the weight of dry matter and the percentage of nitrogen in that dry matter. The highest yield of nitrogen is usually found with the highest yield of dry matter for the reason that the percentage of nitrogen does not vary a great deal. The highest yield from an individual cylinder was 1.54 gm. with nitrate of soda in Series A. The highest yields in 1915 were 1.428 gm. and 1.429 gm. with nitrate of soda in Series A and C, respectively. The highest yields in 1914 were 1.557 gm., 1.585 gm. and 1.559 gm. with nitrate of soda in Series A, B and C, respectively. Naturally, the yields are lower with the higher percentages of sand, though even here they are fairly well maintained.

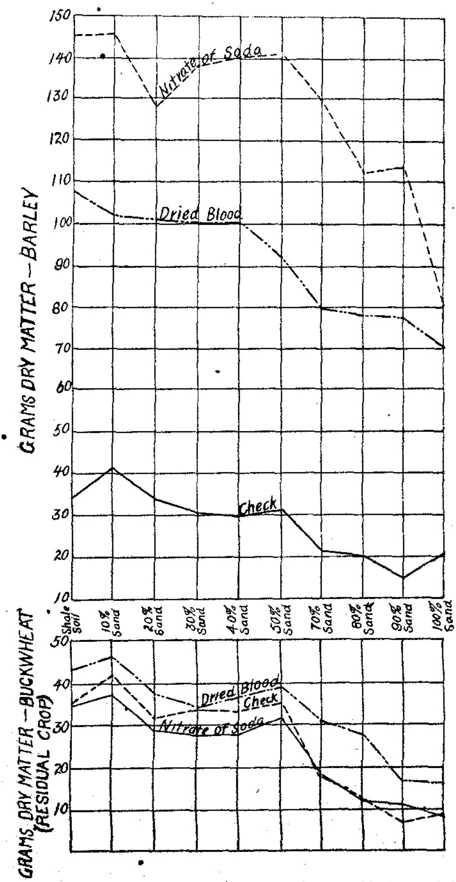

Fig. 2.—Weight of dry matter. First crop above, residual crop below.

THE PERCENTAGE OF NITROGEN RECOVERED

The percentage nitrogen recovery is obtained by subtracting from the total recovery on the treated cylinders of a given series the amount recovered on the check cylinders for that series, dividing the remainder by the amount of nitrogen applied for the crop, and pointing off for per cent. Without exception, the recovery from the nitrate is higher than from dried blood. The highest recovery, 74.8, is from Series A, and the next highest, 65.84, from Series D. A recovery of more than 60 per cent was also obtained with nitrate of soda from Series E, F, G and I, and the average recovery for the nitrate for all series was 60.64. A recovery of 50 per cent with nitrate in pure sand, Series J, and 61 per cent in 90 per cent sand, Series I, is exceptional, and indicates that the loss of nitrate through leaching is not excessive where the rainfall is well distributed and not excessive at any one time.

The highest recovery with dried blood is 51.95 per cent in Series D, and the next highest, 49.48 per cent, in Series C. The remaining series, with the exception of J, show a recovery varying from about 35 to 45 per cent, J alone falling below 35 per cent. The average recovery from dried blood, all series, is 41.23 per cent, which is slightly less than the corresponding figures for last year. On the other hand, the average recovery from nitrate is nearly 6 per cent greater than for last year. The average recovery from nitrate for the first five series is 62.83 per cent, and the average from dried blood for the same series is 47.21 per cent. It is significant that these figures are so closely in agreement with figures that have been obtained in similar work at this Station for a number of years.[1]

RESIDUAL CROP—BUCKWHEAT, 1916

Following the barley, the cylinders were seeded to buckwheat without any further addition of fertilizer, the object of this being to utilize any of the nitrogen not taken by the first crop. The buckwheat made fair growth and was harvested September 6. The crop from each cylinder was dried and weighed, and samples analyzed for the nitrogen content. The results are set forth in Table II.

As has frequently happened in previous years, the average yield from the check cylinders exceeds the average yields from the nitrate cylinders. This is undoubtedly to be explained on the ground that the nitrate of soda furnishes readily available nitrogen for the first crop, which crop uses practically all of this nitrogen and in addition is stimulated to use more of the nitrogen of the soil organic matter than the crop in the check cylinders. It thus comes about that for the second crop there is actually less available nitrogen in the nitrate cylinders than in the check cylinders, although the latter have no nitrogen applied to them. This gives further

[1] N. J. Agr. Exp. Sta. Ann. Rpts. 1911, 1912, 1913, 1914 and 1915. Voorhees, E. B., and Lipman, J. G., Investigations relative to the use of nitrogenous materials. N. J. Agr. Exp. Sta. Bul. 221, 52 p., 1909. Lipman, J. G., Blair, A. W., Owen, I. L., and McLean, H. C., Factors relating to the availability of nitrogenous plant foods. N. J. Agr. Exp. Sta. Bul. 251, 55 p., 7 pl., 2 fig., 1912. Lipman, J. G., Blair, A. W., Investigations relative to the use of nitrogenous plant foods, 1898–1912. N. J. Agr. Exp. Sta. Bul. 288, 126 p., 10 fig., 1916.

Table II

Residual Crop of Buckwheat and Summary for Both Crops, 1916

SERIES		Dry Matter, gm. Per Cylinder	Dry Matter, gm. Average	Per Cent Nitrogen	Nitrogen, gm. Per Cylinder	Nitrogen, gm. Average	Increase Over Check, gm.	Per Cent Nitrogen Recovered	Summary for Both Crops: Total Dry Matter, gm.	Total Nitrogen, gm.	Nitrogen Increase Over Check, gm.	Per Cent Nitrogen Recovered	Relative Availability
A	1	34.9		1.1492	.401								
	2	37.0	35.95	1.1400	.422	.4115			69.90	0.7745			
	3	36.4		1.3315	.485								
	4	33.7	35.05	1.3045	.440	.4625	.0510	3.31	180.30	1.9775	1.2030	78.12	100.00
	5	45.5		1.2403	.564								
	6	41.0	43.25	1.1218	.460	.5120	.1005	6.53	160.60	1.5690	0.7945	51.53	65.96
B	1	44.4		1.2677	.563								
	2	39.8	42.10	1.2038	.479	.5210			83.30	0.9780			
	3	33.8		1.4045	.475								
	4	41.0	37.40	1.3224	.542	.5085			183.05	1.8485	0.8705	56.53	
	5	46.4		1.3680	.635								
	6	45.7	46.05	1.3045	.596	.6155	.0945	6.14	158.05	1.7755	0.7975	51.79	91.62
C	1	34.4		1.3224	.455								
	2	28.4	31.40	1.3224	.376	.4155			65.40	0.7735			
	3	28.7		1.3589	.390								
	4	29.5	29.10	1.3133	.387	.3885			157.50	1.5735	0.8000	51.95	100.00
	5	39.2		1.2312	.483								
	6	35.9	37.55	1.3042	.468	.4735	.0600	3.90	148.55	1.5955	0.8220	53.38	102.75
D	1	35.7		1.3224	.472								
	2	31.9	33.80	1.3862	.442	.4570			64.05	0.8220			
	3	26.8		1.3771	.360								
	4	28.2	27.50	1.4045	.396	.3825			165.60	1.7615	0.9395	61.00	100.00
	5	35.5		1.3954	.495								
	6	32.7	34.10	1.2859	.420	.4575	.0005	0.03	134.70	1.6225	0.8005	51.98	85.20
E	1	36.0		1.2677	.456								
	2	30.5	33.25	1.3771	.420	.4380			63.00	0.7000			
	3	26.8		1.4683	.394								
	4	28.7	27.75	1.4045	.403	.3985			168.30	1.7125	0.9225	59.90	100.00
	5	35.9		1.2768	.458								
	6	36.3	36.10	1.3042	.473	.4655	.0275	1.70	136.75	1.4935	0.7035	45.68	76.26
F	1	34.1		1.4136	.482								
	2	36.4	35.25	1.2677	.461	.4715			66.50	0.8665			
	3	32.9		1.4136	.465								
	4	29.5	31.20	1.3133	.387	.4260			172.40	1.8170	0.9505	61.72	100.00
	5	37.1		1.2859	.477								
	6	41.5	39.30	1.3680	.568	.5225	.0510	3.31	131.70	1.4795	0.6130	39.81	64.50
G	1	15.4		1.3498	.208								
	2	20.5	17.95	1.2768	.262	.2350			39.10	0.4960			
	3	20.0		1.4045	.281								
	4	16.7	18.35	1.4410	.241	.2610	.0260	1.69	148.00	1.4980	1.0020	65.06	100.00
	5	31.5		1.3406	.422								
	6	29.4	30.45	1.3589	.400	.4110	.1760	11.43	110.20	1.2190	0.7230	46.95	72.16
H	1	12.7		1.3954	.177								
	2	13.0	12.85	1.3680	.178	.1775			32.80	0.4185			
	3	12.5		1.3680	.171								
	4	12.7	12.60	1.3862	.176	.1735			124.75	1.2275	0.8090	52.53	100.00
	5	26.7		1.3680	.365								
	6	27.9	27.30	1.3954	.389	.3770	.1995	12.95	103.65	1.1870	0.7685	49.90	95.00
I	1	6.0		1.4866	.089								
	2	7.7	6.85	1.4045	.108	.0985			21.35	0.2585			
	3	13.6		1.5326	.208								
	4	8.0	10.80	1.4410	.115	.1615	.0630	4.09	124.55	1.2615	1.0030	65.13	100.00
	5	16.8		1.4592	.245								
	6	16.8	16.80	1.5504	.260	.2525	.1540	10.00	94.55	0.9755	0.7170	46.56	71.49
J	1	5.5		1.6051	.088								
	2	12.2	8.85	1.5504	.189	.1385			29.05	0.3705			
	3	10.9		1.6690	.182								
	4	5.2	8.05	1.4597	.076	.1290			88.50	1.1360	0.7655	49.70	100.00
	5	17.5		1.4774	.258								
	6	14.6	16.05	1.5280	.222	.2400	.1015	6.59	86.15	0.9460	0.5755	37.37	75.19
Average	1												
	2		25.83	1.3438		.3364			53.45	0.6544			
	3												
	4		23.78	1.4069		.3292			151.30	1.5812		60.16	100.00
	5												
	6		32.70	1.3480		.4329			126.70	1.3850		47.50	80.00

evidence of the slight residual effect to be obtained from nitrate of soda. At the same time the high percentage of recovery proves that the loss of this material from leaching, or otherwise, is not so great as the loss from dried blood, for the combined average recovery from the nitrate is greater than the combined average recovery from dried blood. That is, the first crop uses the nitrate so effectively that the net result exceeds the net result from dried blood although the latter has more residual effect than the nitrate.

The highest weight of dry matter is found in Series B, and this applies to the check as well as to the nitrate and dried blood. The yields for the first six series are fairly uniform, but for the last four there is a decided falling off, the lowest yields being found in Series I and J, 90 per cent sand and 100 per cent sand, respectively.

The buckwheat yields are well illustrated by the curves in the lower part of figure 2, page 373. It will be noted from these curves that the yields for the three treatments run fairly close together, and that the yields from the check cylinders run between those for the dried blood and nitrate cylinders, except for 70 and 90 per cent of sand, where they fall just below the nitrate yields. A reason has already been suggested for the higher yield on the check cylinders.

PERCENTAGE OF NITROGEN IN THE DRY MATTER—RESIDUAL CROP

The variations in percentage of nitrogen are not great, either in regard to fertilizer treatment or mechanical composition of the soil. It is significant that the highest percentages are found in the samples from Series J where pure sand was used, and the second highest from Series I with 90 per cent sand. Thus, as previously pointed out, where the normal development of the plant is in some way arrested or depressed, there seems to be an abnormal storing up of nitrogen. In this instance the soil, which in the one case is almost pure quartz, and in the other 90 per cent quartz, is the abnormal condition.

In the remaining series the percentage of nitrogen is fairly constant. The average for the checks in all series is 1.34 per cent, for the nitrate of soda 1.41 per cent, and for the dried blood 1.35 per cent.

The average amount of nitrogen recovered from the checks and from the nitrate cylinders is almost the same, while the amount recovered from the dried blood cylinders is about 0.10 per cent higher than either of the others.

RECOVERY OF NITROGEN—RESIDUAL CROP

As in previous years, the recovery of nitrogen from nitrate of soda through the residual, or second crop, is almost nil, there being no recovery whatever in seven out of the ten series, and less than 5 per cent in the other three. There is some recovery from dried blood in all series, though the amount in Series D is negligible. The average recovery for the last four series is 10.24 per cent and the average for the first six is 3.61 per cent. This is what might be expected, since the condition was reversed in the first crop, that is, the average for the last four series was less than the average for the first six.

It is quite evident, therefore, that a part of any organic nitrogen that is not used by the first crop may be utilized by the second or residual crop. It is quite as evident that the residual crop stands little chance of securing nitrate nitrogen that was applied for the first crop if that crop was normal and the application of nitrate an average one.

There is more residual effect from the blood in the lighter than in the heavier soils. In the first crop, however, the recovery is less in the lighter than in the heavier soils.

Dry Matter and Nitrogen—Both Crops

The combined yield of dry matter for the two crops is graphically shown by curves in the upper part of figure 3. From these curves it will be noted that, notwithstanding the small residual effect from the nitrate, the yield with this material is greater for all dilutions than for dried blood. In the combined crops, however, the yield with blood does approach a little nearer to the yield with nitrate than it did in the first crop. This is especially true in the case of sand, where the total yield with blood is nearly equal to the total yield with nitrate.

Even with its greater residual effect, dried blood does not give the yields that nitrate of soda gives. If this is true of high-grade dried blood, there is good reason to believe that it is equally true of such materials as tankage and garbage tankage.

The percentage of nitrogen recovered from the two materials in the combined crops is indicated by curves in the lower part of figure 3. Here it will be noted, the blood has made some gain on the nitrate, the recovery in cylinders with 80 per cent of sand being almost as great as from the nitrate under the same conditions, and the recovery from cylinders with 20 per cent of sand being greater than with the nitrate, which gives it a relative availability slightly above 100.

The relative availability is determined by taking the recovery from nitrate in each series as 100 and comparing this with the recovery from blood. The widest difference for the combined crops is noted with the pure shale soil, Series A. This is, no doubt, to be attributed to the poor mechanical condition of this soil, which prevents thorough oxidation of the organic matter.

Taking 100 as the availability for nitrate, the average availability for blood is 80.01. The corresponding figures for 1915 are 86.36; for 1914, 85.66, and for 1913, 91.2. The average for the first crop, 1916, is 68.47. The low figures for 1916 are probably due to the fact that the rainfall for the season was not excessive at any time and was well distributed during the period when the barley was growing, and thus there was a minimum loss of nitrate through leaching. The excellent and uniform growth made by the barley is a witness to this fact.

The Theoretical and Actual Recoveries From the Shale Soil

A comparison of the amount of nitrogen that should be recovered from the organic matter of the shale soil in the various dilutions (as calculated from the recovery from the pure shale) with the net amount actually recovered, is of interest.

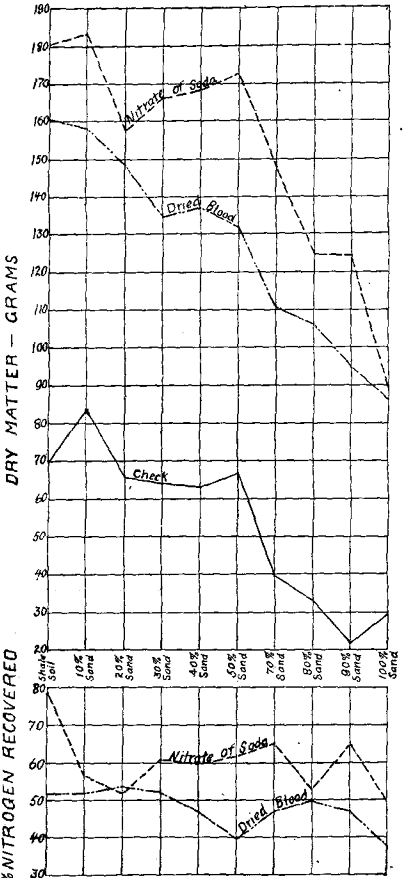

Fig. 3.—Combined crops. Dry matter above; pe. cent nitrogen recovered, below.

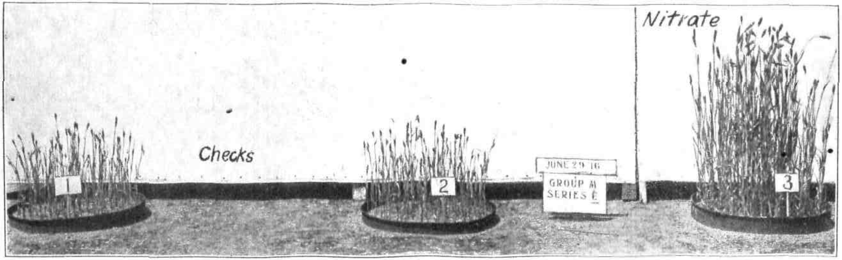

Fig. 1.—Series E: 40 per cent sand; cylinders 1 and 2, checks; 3, nitrate of soda.

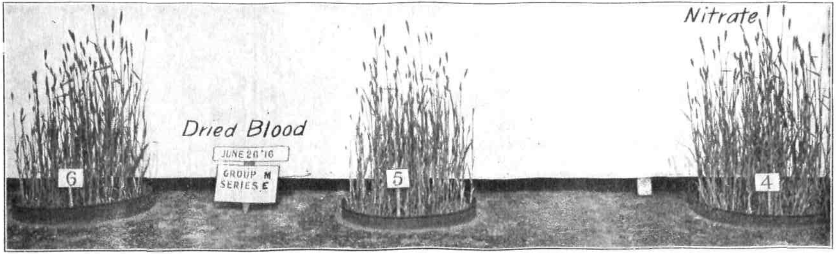

Fig. 2.—Series E: 40 per cent sand; cylinder 4, nitrate of soda; 5 and 6, dried blood.

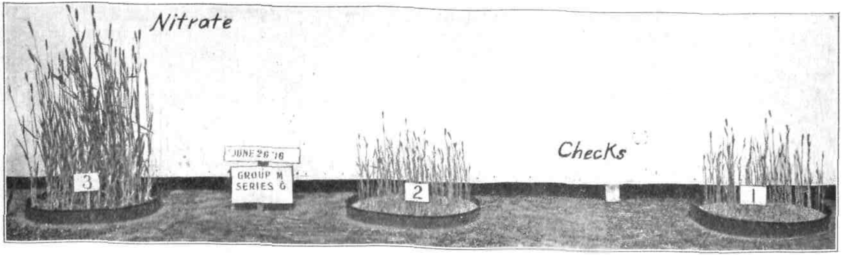

Fig. 1.—Series G: 70 per cent sand; cylinders 1 and 2, checks; 3, nitrate of soda.

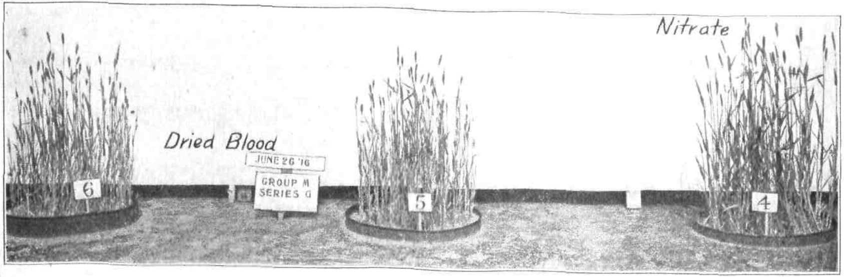

Fig. 2.—Series G: 70 per cent sand; cylinder 4, nitrate of soda; 5 and 6, dried blood.

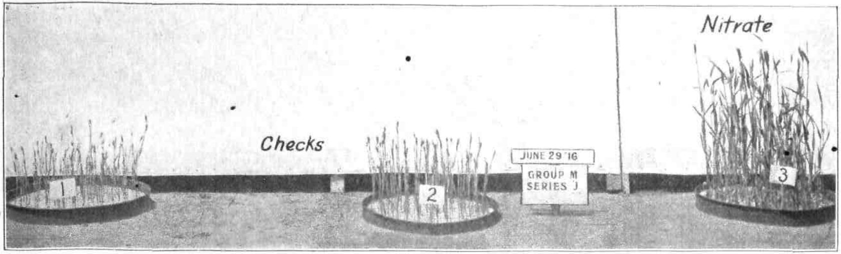

Fig. 1.—Series J: All sand; cylinders 1 and 2, checks; 3, nitrate of soda.

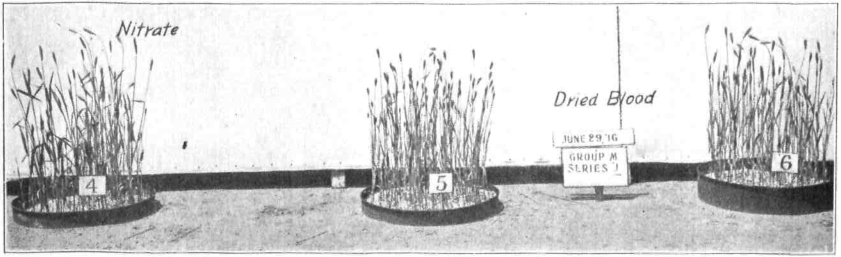

Fig. 2.—Series J: All sand; cylinder 4, nitrate of soda; 5 and 6, dried blood.

By reference to the column headed "Total Nitrogen in Both Crops," it will be seen that there was recovered from the check cylinders of Series A 0.7745 gm. of nitrogen. From the corresponding cylinders of Series J, pure sand, there was recovered 0.3705 gm. of nitrogen, representing a small amount of nitrogen that was in the sand, that which was in the seed and any that may have been fixed by non-symbiotic bacteria. The difference between these amounts, 0.404 gm., may fairly be taken as representing the actual net recovery from the shale soil cylinders.

Since the check cylinders of Series B were 90 per cent shale instead of entire shale soil, the theoretical recovery from this would be 90 per cent of 0.404 which is 0.364. The actual amount of nitrogen recovered in the combined crops from the check cylinders of Series B was 0.978 gm., and subtracting from this the 0.3705 gm. (combined recovery from check cylinders in pure sand), there remains 0.608 gm., which represents the net recovery from the shale soil of Series B. In a similar manner the theoretical and actual recovery from the humus of the shale soil for the combined crops with various dilutions have been calculated, and the results are shown in Table III.

Table III

Nitrogen Recovered From Shale Soil in the Combined Crops

Composition of the Soil.	*Theoretical Amount of Nitrogen Recovered, Gm.*	*Actual Amount of Nitrogen Recovered, Gm.*
100% Shale Soil,	.404	.404
90% " "	.363	.608
80% " "	.323	.403
70% " "	.283	.452
60% " "	.242	.419
50% " "	.202	.496
30% " "	.121	.126
20% " "	.081	.048
10% " "	.040	.000

From the table it will be noted that with two exceptions, namely, Series H and I, the actual recoveries surpass the theoretical amounts so calculated from the recovery from the shale soil alone. In most cases the actual recovery is decidedly in excess of the theoretical.

As previously pointed out this indicates an improved condition of the soil when diluted with sand, due to better aeration, and, therefore, more complete utilization of the soil organic matter.

Summary

1. This is the sixth report on the availability of nitrate of soda and dried-blood nitrogen, when applied in equivalent amounts to shale soil and various dilutions of the shale soil.

2. For the shale soil and for each dilution there are two check cylinders, two nitrate cylinders and two dried-blood cylinders, and two crops were grown in these cylinders; a main crop, barley, and a residual crop, buckwheat.

3. For the main crop, the nitrate cylinders invariably gave the highest yield, the dried blood standing second and the check cylinders lowest. In the second crop, the yield with dried blood stands highest, and with only two exceptions, the nitrate slightly below the check cylinders. This is apparently due to the fact that the first crop used practically all of the nitrate, and being thus stimulated, also used more of the nitrogen of the soil organic matter than the crops on the check cylinders. As a result the residual crop on the check cylinders actually had at its disposal more available nitrogen than the residual crop on the nitrate cylinders.

4. For the first crop the mechanical condition of the soil, and the fertilizers used, do not appear to have very much influence upon the percentage of nitrogen in the dry matter. For the second crop the percentage of nitrogen in the dry matter is distinctly higher in Series I and J, where the soil is 90 per cent sand and all sand, respectively.

5. For the first crop the average percentage of nitrogen recovered for all series with nitrate of soda was 60.64, and with dried blood 41.23. The highest recovery was 74.8 per cent, with nitrate, in Series B. For the combined crops the average for all series was 60.16 for nitrate, and 47.5 for dried blood.

6. In the second or residual crop, there was no recovery of nitrogen from 7 out of the 10 nitrate cylinders, and in no one of the three from which there was some recovery did the amount reach 5 per cent. The average recovery from the dried-blood cylinders was 6.27 per cent.

7. Although the dried blood shows a decidedly higher recovery in the second crop, the nitrate stands first when the recoveries from the combined crops are considered. That is, the initial effect of the nitrate is greater in all cases, and distinctly greater on an average than the sum of the initial and residual effects of the blood.

8. In accordance with results obtained in this experiment, if 100 represents the availability of nitrate nitrogen, then the availability of dried-blood nitrogen would be 80.01.

9. With these facts, backed by experiments covering a period of several years before him, the American farmer cannot longer afford to pay more for organic nitrogen than for nitrate nitrogen.

10. Mixing sand with a heavy soil allows better aeration and drainage and results in a more complete utilization of the nitrogen of the soil organic matter.

II

THE CONTINUOUS GROWING OF WHEAT AND RYE WITH AND WITHOUT A LEGUME AS GREEN MANURE

The plan of this experiment was described in the annual report for 1912, where the results for the first five years were given in detail.[1] Further

[1] Lipman, J. G., Blair, A. W., Owen, I. L., and McLean, H. C., Report of the soil chemist and bacteriologist. In N. J. Agr. Exp. Sta., 33d Ann. Rpt. (1912), p. 261.

accounts have appeared in the annual reports for 1913, 1914 and 1915. For convenience the general plan may be briefly restated.

Plan of Experiment

For a number of years the Experiment Station has been conducting experiments to determine to what extent the nitrogen supply of the soil may be maintained by the growing of leguminous crops between the main crops of the rotation. One of these experiments is the continuous growing of wheat and rye with and without a leguminous crop as a source of nitrogen. It is not contended that it is profitable or advisable to grow these two crops continuously without rotation, but it seemed worth while to determine whether it is possible thus to grow them, and what would be the effect of such practice upon the chemical and physical composition of the soil.

The soil on which this experiment is being carried out is a sandy loam, and prior to starting the work in 1908, was in a poor state of cultivation. The plots are 1/20 acre in size and designated as 68, 69, 70 and 71; 68 and 70 being the rye plots and 69 and 71 the wheat plots. Each year, immediately following the cutting of the grain, 70 and 71 are disked and seeded to soybeans (cowpeas for the first four years) and these are allowed to grow until about two weeks before the time for seeding the wheat and rye, when they are turned under as a green manure crop. The other two plots, 68 and 69, are left in stubble during the time that the leguminous crop is growing and are plowed when the cover crop on 70 and 71 is turned under. The plots were in corn during the summer of 1908, and therefore no leguminous crop preceded the wheat and rye on plots 70 and 71 that fall. In the fall of 1908 all the plots received a treatment of ground limestone equivalent to 1 ton per acre, and in the spring of 1913 a further treatment of this material equivalent to 2 tons per acre. Each year all plots receive acid phosphate at the rate of 400 pounds, and muriate of potash at the rate of 200 pounds, per acre, but no commercial nitrogen is applied. Partly on account of poor inoculation and partly on account of disease, the cowpeas seeded in the years of 1909 to 1912, inclusive, did not do well, and on this account the change was made to soybeans in 1913, with distinctly better results.

The yields of grain and straw and the nitrogen recovered in the crops, calculated to the acre basis, for 1916 are shown in Tahle IV.

Crop of 1916

On July 13, 1915, Plots 70 and 71 were thoroughly disked and seeded to Ito San soybeans, the beans being harrowed in. Germination was good and the plots showed a splendid inoculation, so that when they were turned under on September 17 they were 2 feet high or more. Pods were well set, though not mature at this time. Thus in 60 days, and between the two main crops, an excellent green manure crop was produced. While the beans were growing, Plots 68 and 69 remained in stubble. During this time note was made of the fact that there was a good deal of white clover on Plots 68 and 69. Note is made of this because the clover supplies to these plots a certain amount of nitrogen, which necessarily introduces some error into the work, in that it makes the effect of the soybeans on Plots

70 and 71 appear less than it really is. This tendency of clover to come in where the supply of minerals is well kept up has been noted elsewhere.[1]

On September 30, 20 pounds of acid phosphate and 10 pounds of potassium chloride were applied to each plot, and 68 and 70 were seeded to rye and 69 and 71 to wheat. Germination was good and the rye and wheat made very good growth during the winter and spring indicating that the green manure was even more effective than in previous years.

The crop was harvested July 14 and samples prepared for analysis in the usual way. The yields of grain and straw, the percentage of nitrogen in the dry matter, and the nitrogen recovered in the crop are indicated in Table IV.

Table IV

Rye and Wheat with and Without a Legume as a Green Manure Crop, 1916 (1/20) acre plots

	Grain Per Plot			Straw Per Plot			Per Acre		
	Dry Matter, Lbs.	Per Cent Nitrogen	Nitrogen, Lbs.	Dry Matter, Lbs.	Per Cent Nitrogen	Nitrogen, Lbs.	Grain, Bu.	Straw, Lbs.	Total Nitrogen, Lbs.
68 Rye alone, ...	46	1.860	0.8556	77	.392	.3018	15.33	1540	23.15
69 Wheat alone, ...	27	2.143	0.5786	52	.611	.3177	9.00	1040	17.92
70 Rye followed by soybeans, ...	65	1.961	1.2747	139	.547	.7604	21.66	2780	40.70
71 Wheat followed by soybeans, ...	52	2.180	1.1336	127	.648	.8230	17.33	2540	39.13

Again the yields are not large, but when it is remembered that this is the ninth crop without purchased nitrogen it must be admitted that the results are fairly satisfactory. It will be noted that the yield of 17.33 bushels of wheat on Plot 71 is almost double the yield on Plot 69 and that the yield of straw is more than doubled. That is, the green manure crop has resulted in an increase amounting to 8⅓ bushels of wheat and 1,500 pounds of straw. Allowing $1.00 per bushel for the wheat and $10.00 per ton for the straw, the money value of the increased yield would be $15.83. If $4.00 be allowed for the cost of the leguminous crop there would still be a net return of nearly $12.00 more than from the non-legume plot. The yield of 21.66 bushels of rye on Plot 70 is a little better than one-third more than the yield on Plot 68 and the yield of straw is almost doubled.

The percentage of nitrogen in the grain is very nearly the same as for 1915, but in the straw it is distinctly higher than for the preceding year.

[1] Lipman, J. G., and Blair, A. W., Field experiments on the availability of nitrogenous fertilizers. N. J. Agr. Exp. Sta. Bul. *260*, 33 pp., 4 pl., fig. 1, 1913.

PLATE IV.

Fig. 1.—Continuous rye without legume as green manure.

Fig. 2.—Continuous rye with legume as green manure.

PLATE V.

The two shocks of wheat on the left were grown on $^1/_{20}$ acre with a legume as green manure; the one on the right was grown on $^1/_{20}$ acre without a legume as a green manure.

This is especially true of the wheat Plots 69 and 71, the percentages for 1915 being 0.364 and 0.394, respectively, and for 1916, 0.611 and 0.648, respectively. The rather high percentage of nitrogen in the straw did not, however, cause lodging of the grain.

Attention should again be directed to the fact that the percentage of nitrogen in the dry matter, both grain and straw, from the legume plots, is higher than it is in that from the non-legume plots. This may be taken as an indication that the plant having at its disposal available nitrogen, will use it, up to a certain point at least. It also means a food material or feeding material richer in protein, and as previously pointed out, if this additional protein equivalent is taken from the air by means of leguminous plants, it represents clear gain. If, on the other hand, it represents purchased nitrogen, it would not necessarily be a profitable investment.

The amount of nitrogen recovered in the crop on Plot 71, calculated on the acre basis, is 21.2 pounds more than the amount recovered on Plot 69. This would be equivalent to about 137 pounds of nitrate of soda, and if this may be taken as the amount of nitrogen accumulated by the preceding crop of soybeans—and this assumption seems entirely reasonable—it represents a very fair accumulation for 60 days. If this rate could be maintained throughout the year, it would mean the equivalent of more than 800 pounds of nitrate of soda.

III

THE INFLUENCE OF BACTERIA CARRIED IN MANURE ON THE DECOMPOSITION OF GREEN MANURES (LEGUME AND NON-LEGUME)

The experiment was planned to study the effect of the bacteria conveyed in cow manure, on the decomposition of a green manure crop. It further contemplates a comparison of legumes and non-legumes as green manure crops in continuous corn growing. An account of the first five years of the work will be found in the annual report for 1912, and an account of the succeeding years in the reports for 1913, 1914 and 1915.

Plan of Experiment

The experiment is conducted on eight $^{1}/_{20}$-acre plots. The soil is a gravelly loam, inclining to a sandy loam. It was originally much neglected and is deficient in nitrogen, this being the chief limiting factor.

When the experiment was begun ground limestone was applied to all plots at the rate of one ton per acre and each plot also received 30 pounds of a fertilizer made up of 10 pounds of fish, 15 pounds of acid phosphate and 5 pounds of muriate of potash. In the spring of 1913 ground limestone was again applied, this time at the rate of 2 tons per acre. The plots receive annual applications of phosphoric acid and potash so that a want of these elements may not become the limiting factor. The plan, including special treatment, is as follows:

LEGUME SECTION

Plot 49—Corn followed by vetch and crimson clover as green manure; no farm manure.

Plot 50—Corn followed by vetch and crimson clover and 50 pounds of manure.

Plot 51—Corn followed by vetch and crimson clover and 100 pounds of manure.

Plot 52—Corn followed by vetch and crimson clover and 200 pounds of manure.

NON-LEGUME SECTION

Plots 53 to 56—Same as above, with the exception that rye takes the place of the vetch and crimson clover.

The manure is preferably that which has been well rotted and is applied broadcast over the green manure crop before plowing under. The amount is purposely kept small in order that the quantity of fertilizing constituents in the manure may be kept to the minimum.

Crop of 1916

On August 18 and 19, 1915, the cover crops were seeded in the corn in accordance with the plan—Plots 49 to 52, two pounds of vetch and one pound of crimson clover, and Plots 53 to 56, four pounds of rye. Germination was good and the growth during the fall was satisfactory. In the following spring the vetch and crimson clover made fair growth but the rye was thin and small. At the time of plowing the plots, May 8, the vetch was making a splendid growth, but the rye was still thin and backward. On May 5 the manure was applied as indicated in the plan, and on the eighth and ninth the plots were plowed and harrowed, and a few days later fertilizer applied as follows: 15 pounds of acid phosphate, 5 pounds of muriate of potash and 8 pounds of nitrate of soda. The addition of nitrate this year makes a slight change in the experiment, but this seemed necessary for the reason that the nitrogen supply of these plots was not being maintained and consequently the yields were becoming very poor. On May 18 the plots were planted to a yellow dent corn obtained from Burlington County. The rows were run 40 inches each way. Germination was good and the crop grew nicely during the spring and summer. The effect of the nitrate was especially noticeable in the color of the corn and also in the rapid growth during the early summer. The corn on Plots 49 to 52 was, however, decidedly darker in color than that on 53 to 56, thus showing the effect of the leguminous green manure also. During the wind and rain storms near the end of July considerable injury was done to the crop by the blowing over of the stalks. This was corrected as far as possible by raising stalks and putting dirt over exposed roots.

On August 1 the cover crop was seeded and cultivated in with the spike-tooth harrow, but on account of poor germination it became necessary to reseed the rye after the corn was harvested. On September 25 the corn was harvested and put in shocks to dry out, and later it was weighed and samples prepared for analysis in the usual way. The dry weights, calculated on the acre basis, and other analytical data, are shown in Table V.

Table V

Corn 1916 (Calculated to Acre Basis)

Plot No.	SPECIAL TREATMENT	GRAIN			STALKS			COBS			Total Nitrogen, lbs.	INCREASE OVER CHECK		
		Dry Matter, bu.	Per Cent Nitrogen	Nitrogen, lbs.	Dry Matter, lbs.	Per Cent Nitrogen	Nitrogen, lbs.	Dry Matter, lbs.	Per Cent Nitrogen	Nitrogen, lbs.		Dry Matter, Grain, bu.	Dry Matter, Stover, lbs.	Nitrogen, lbs.
	LEGUME SECTION													
49	No Manure, ...	35.00	1.665	32.63	3080	.754	23.22	440	.512	2.25	58.10	....	....	....
50	50 lbs. Cow Manure, ...	37.86	1.628	34.51	3040	.670	24.39	480	.372	1.70	60.69	2.86	600	2.59
51	100 lbs. Cow Manure, ...	38.21	1.637	35.03	3620	.809	29.29	400	.447	2.06	68.38	3.21	560	8.28
52	200 lbs. Cow Manure, ...	42.50	1.544	30.75	3900	.781	30.46	520	.372	1.93	69.14	7.50	900	11.04
	Average, ...	38.39	1.619	34.73	3560	.754	26.84	475	.426	2.01	63.58	....	....	....
	NON-LEGUME SECTION													
53	No Manure, ...	18.21	1.516	15.46	3160	.633	20.00	320	.595	1.90	37.36	....	....	....
54	50 lbs. Cow Manure, ...	25.36	1.591	22.59	3710	.567	21.04	340	.530	1.80	45.43	7.15	570	8.07
55	100 lbs. Cow Manure, ...	20.71	1.684	19.53	3640	.744	27.08	280	.447	1.25	47.86	2.50	440	10.50
56	200 lbs. Cow Manure, ...	28.57	1.488	23.81	3940	.670	26.40	380	.372	1.41	51.62	10.36	840	14.20
	Average, ...	23.21	1.570	20.25	3613	.654	23.63	330	.486	1.59	45.57	....	....	....

The yields are decidedly better than they were last year. This is no doubt due in part to the nitrate of soda which was applied, and partly to the favorable season. Since nitrogen is the limiting factor on these plots, an application of nitrate would be expected to show an immediate response.

The Influence of Manure

For both sections the yield of grain and stover on the manured plots exceeds the yield on the check plot. The yield of grain on the legume section varies from 35 bushels per acre on the check plot to 42.5 bushels on the plot that received 200 pounds of manure. The increase with 100 pounds of manure is, however, only a trifle more than with 50 pounds, so that there seems very good reason for believing that the manure has an effect aside from the actual fertilizing constituents which it contains. On the non-legume section the yield ranges from 18.21 bushels per acre on the check plot to 28.57 bushels on the plot that received 200 pounds of manure. It will be noted, however, that here the yield is actually less with 100 pounds of manure than with 50 pounds, again indicating that the increase over the check plot is not due to the fertilizing constituents in the manure. The inference is that the bacteria in the manure have brought about a more thorough decomposition of the green manure crop with the result that more nitrogen was made available on these plots. The results this year accord, in this respect, with the results of previous years. There was, without exception, more nitrogen recovered from the manured plots than from the check plots, and in this case the increase follows the increase in the amount of manure applied. This may possibly be taken as an indication that the increase is due, in part at least, to the fertilizing constituents in the manure.

The Legume and Non-Legume Sections

It will at once be noted that the yields of grain on the legume section is greater than on the non-legume section, the average for the former being 38.4 bushels per acre, and for the latter, 23.2 bushels per acre. The yields of stover on the other hand are very nearly the same on each.

The average percentage of nitrogen in grain and stalks is slightly higher on the legume than on the non-legume section. This is an indication of more available nitrogen for the crop. The percentage of nitrogen in the grain—both sections—is distinctly higher than it was last year, which would also indicate a better supply of available nitrogen. With a larger yield and a higher percentage of nitrogen it naturally follows that the total yield of nitrogen would be larger than in last year's crop. The average recovery for the legume section is 62.58 pounds and for the non-legume section 45.57 pounds per acre, an increase for the legume section of 18 pounds, equivalent to approximately 115 pounds of nitrate of soda.

The greater increase in total nitrogen made by the treated plots in the non-legume section than in the legume section is to be attributed to the wider difference between the check plot and the treated plots in the former. This is due to the fact that in the legume section the check plot profits by the nitrogen secured by the legume from the air, and as a consequence

the yield of nitrogen on this plot approaches quite closely the yield on the treated plots, thus making the increase due to the treatment appear small, while on account of the wider difference between check plot and treated plots on the non-legume section, the increase appears somewhat larger.

Summary

1. This is a report of work which was begun in 1908, an account of which up to this year may be found in the annual reports from 1912 to 1915, inclusive.

2. Manure is used at the rate of 1,000, 2,000 and 4,000 pounds per acre as compared with a check, in the continuous growing of corn, to determine whether the bacteria thus brought into the soil hasten the decomposition of green manure crops—legume and non-legume.

3. The yield of grain was greater on the manured plots than on the check plots, but increase in amount of manure applied does not always give a proportionate increase in yield. That is, the increased yield could hardly be attributed solely to the fertilizing constituents contained in the manure for the reason that as great or greater increases in yield are sometimes obtained with 50 pounds of manure than with 100 pounds.

4. The total nitrogen recovered in the crop is greater for the manured plots than for the check plots—both sections—and here the increase follows the increase in the amount of manure applied. This, however, has not always been true in the past.

5. The average yield of grain for the legume section was 38.4 bushels per acre and the average for the non-legume section 23.2 bushels. The yields of stover for the two sections were 3,560 pounds and 3,613 pounds, respectively.

6. The nitrogen recovered in the crop was at the rate of 63.58 pounds per acre for the legume section and 45.57 pounds for the non-legume section.

7. The increase in amount of nitrogen recovered in the crop for the different amounts of manure is greater for the non-legume section than for the legume section. This is due to the fact that in the legume section the check plot secures a certain amount of its nitrogen from the air, thus making the difference between this plot and the treated plots small, whereas the difference between the check plot and treated plots on the non-legume section is comparatively large.

IV

INFLUENCE OF LIME UPON THE YIELD OF DRY MATTER AND NITROGEN CONTENT OF ALFALFA

The results of three years of experimental work on the growing of alfalfa with different amounts of lime seem to justify the publication of a brief account of the work.

The experiment is being conducted on four 1/20-acre plots designated as *E*, *F*, *G* and *H*. The soil is a gravelly loam of fair quality. The subsoil is a loam grading into a sandy loam at a depth of 20 inches to 2 feet.

Previous to 1908 this land had been neglected and probably had not been limed for many years. During the years of 1908 to 1912 the plots were

seeded to various leguminous crops, including sweet clover, vetch, and beans. The fertilizer applied was usually 20 pounds of acid phosphate and 5 to 10 pounds of muriate of potash.

Table VI

Influence of Lime on the Yield and Nitrogen Content of Alfalfa

PLOT	Dry Matter, lbs.	Per Cent Nitrogen	Nitrogen, lbs.	Dry Matter, lbs.	Per Cent Nitrogen	Nitrogen, lbs.	Dry Matter, lbs.	Per Cent Nitrogen	Nitrogen, lbs.
	1st Cutting, 1914			1st Cutting, 1915			1st Cutting, 1916		
E, ...	2350	1.785	41.95	1625	1.931	31.38	2400	2.273	54.56
F, ...	1975	1.923	37.98	1960	2.334	45.75	3120	2.176	67.90
G, ...	1600	1.952	31.23	2260	2.269	51.29	3260	2.672	87.09
H, ...	2000	1.972	39.44	2850	2.494	71.08	3325	2.769	92.06
	2d Cutting, 1914			2d Cutting, 1915			2d Cutting, 1916		
E, ...	1120	†	....	1700	2.494	42.13	2025	2.709	54.86
F, ...	1080	†	....	2200	2.428	53.42	2160	3.010	65.02
G, ...	1440	†	....	2480	2.663	66.04	2600	2.800	72.80
H, ...	1320	†	....	2700	2.616	69.63	2475	3.064	75.83
	3d Cutting, 1914			3d Cutting, 1915			3d Cutting, 1916		
E, ...	600	2.505	15.03	1050	1.993	20.93	1100	2.380	26.18
F, ...	540	2.425	13.10	1160	2.538	29.44	1560	2.535	39.55
G, ...	780	2.478	19.33	2160	2.339	50.52	1780	2.891	51.46
H, ...	980	2.425	23.77	2000	2.418	48.36	1600	2.845	45.52
	All Cuttings, 1914			All Cuttings, 1915			All Cuttings, 1916		
	Total	Average	Total	Total	Average	Total	Total	Average	Total
E, ...	4070	2.145	*87.30	4375	2.139	94.44	5525	2.454	135.60
F, ...	3595	2.174	*78.16	5320	2.433	128.61	6840	2.574	172.47
G, ...	3820	2.215	*84.61	6900	2.424	167.85	7640	2.768	211.85
H, ...	4500	2.199	*96.96	7550	2.509	189.07	7400	2.893	213.41

† Sample lost before the nitrogen determination was made.
* Total for second cutting calculated from the average per cent of nitrogen.

During the summer of 1912, *E* was in sweet clover, and *G* and *H* in beans. In the fall of that year *F* was seeded to vetch. During the summer of 1913 the plots were plowed and prepared for seeding to alfalfa. Plot *E*, as the check plot, received no ground limestone; plot *F* received 50 pounds, plot *G* 100 pounds, and plot *H* 200 pounds. Each plot received 30 pounds of a general fertilizer made up of 15½ pounds of acid phosphate, 9 pounds of fish and 5½ pounds of muriate of potash.

On August 14 the four plots were seeded to alfalfa, 1½ pounds to the plot. There was good germination and fair growth during the fall. The rainfall for September was about 3 inches, while for October it was about 10 inches. For the years 1914, 1915 and 1916 three cuttings each year have been taken from the plots. Following the first cutting each year, the plots receive 30 pounds of fertilizer each, made up of 20 pounds of acid phosphate and 10 pounds of muriate of potash. The weights of dry matter, percentage of nitrogen in the dry matter, and other data calculated to the acre basis, are shown in Table VI.

Crop of 1914

The average yield of dry matter for the first cutting is not quite one ton per acre, the average for the second cutting between one-half and three-quarters of a ton, and the average for the third cutting a little over one-third of a ton. The highest yield in the first cutting was from Plot *E*, without lime, but in the second and third cuttings the tendency is towards increased yields with increase in amount of limestone applied—Plots *E* and *F*, however, being exceptions to this. The largest total yield for the year, *2¼ tons*, was on Plot *H*, which received limestone at the rate of 2 tons per acre; *E* follows next with a yield of a little over 2 tons. For the first cutting the percentage of nitrogen in the dry matter increases slightly with increased amount of limestone, and this is true of the average of the two cuttings with the exception of *H*, which falls a little below *G*. It is not true of the third cutting. On account of the loss of the samples for the second cutting it is not possible to report the total nitrogen for the crop of this year.

Crop of 1915

The average amount of dry matter for the first and second cuttings is well above one ton per acre, and in the third cutting it is more than a ton for *G* and just one ton for *H*. For the first and second cuttings there is a gradual increase in weight from the unlimed plot to the plot that received limestone at the rate of 2 tons per acre. This is likewise true for the third cutting, with the exception of Plot *H*, which falls slightly behind *G*. The averages show a decided increase from a little more than 2 tons on *E* to 3¾ tons on *H*.

It would thus appear that the half ton of limestone on Plot *F* had resulted in an increase of nearly a half ton of hay; that the ton of limestone on Plot *G* had resulted in an increase of 1¼ tons of hay, and that the 2 tons of limestone on Plot *H* had resulted in an increase of 1¾ tons of hay. In any case, the additional hay for this year alone would a great deal more than pay for the limestone applied. While the percentage of nitrogen in the dry matter does not steadily increase from the unlimed plot to the plot receiving the largest application, the tendency is in that direction. For example, the average for Plot *E* is 2.139 per cent. and the average for Plot *H* is 2.509 per cent.

With respect to total nitrogen recovered in the crop, there is a very decided increase from Plot E to Plot H, the amount recovered from *H* being twice that recovered from *E*. Certainly this 94½ pounds of additional nitro-

gen must be credited to the effects of the ground limestone! To say that the limestone resulted in a better physical condition of the soil and better inoculation, bringing about greater accumulation of atmospheric nitrogen, is perhaps stating the chief causes which lead to the increased yield. The increase of *H* over *G* is only about 21 pounds of nitrogen, but this alone would just about pay for the additional ton of limestone.

Crop of 1916

The first cutting gave an average of a little more than 1½ tons per acre; the second something over a ton, and the third between three-fourths ton and one ton. The total for the year ranges from 2¼ tons on *E* to more than 3¾ tons on *G*, with only a little less on *H*. This means that the one-half ton of limestone on *F* has resulted in an increased yield amounting to over 1,300 pounds; the ton of limestone on *G* an increase of 2,100 pounds, and the 2 tons on *H* an increase of 1,875 pounds. Here the yield with one ton of limestone is greater than with two tons.

Again, there is a tendency for the percentage of nitrogen in the dry matter to increase as the amount of limestone is increased. For each cutting the percentage in the sample from the check plot is less than the percentage in the limed plots, with the exception of the first cutting on Plot *F*. In the average for the year there is a gradual increase from 2.454 per cent on Plot *E* to 2.893 per cent on Plot *H*.

It is of especial interest to note how the yields of dry matter and also the percentage of nitrogen in the dry matter have increased, almost without exception, from year to year. Throughout the three cuttings there is an increase in total nitrogen recovered in the crop as the amount of limestone was increased, the least in each case being on the check plot, and the most on the plot that received 2 tons of limestone. The totals for the year are about 25 to 40 pounds greater than the corresponding totals for the preceding year.

The total yield on Plot *E* was 135.6 pounds, and the total on Plot *G* 211.35 pounds, giving a difference of about 76 pounds in favor of *G*. The difference between *E* and *H* is only about 2 pounds greater, and therefore is not sufficient to justify the use of the extra ton of limestone. It seems entirely fair to credit this increase to the lime, and since 76 pounds of nitrogen are equivalent to about 500 pounds of nitrate of soda, there is justification for the claim that the lime has resulted in putting into available form nitrogen equivalent to 500 pounds of nitrate of soda.

This would be largely true even if it should be held that the major portion of the 76 pounds of nitrogen came from the soil rather than from the air, for without the lime it would have remained practically unavailable. That this additional nitrogen must have come largely from the air, however, will be presently pointed out. Mention should be made of the increase in total nitrogen from year to year. With an initial application of only 9 pounds of fish per plot (180 pounds per acre), the effects of which must have been practically nil after the first year, the crop of alfalfa yields a larger amount of nitrogen each year. Possibly the maximum may have been reached in the

crop of 1916, but if this be granted, still the results are exceedingly encouraging.

How Much of This Nitrogen Came From the Air?

This question must of necessity be answered indirectly. Nearby the alfalfa plots and embracing the same type of soil are two other plots designated as 68 and 69 on which rye and wheat, respectively, have been grown since 1909 (1909 to 1916, inclusive), without commercial nitrogen or green manure crops, save some volunteer white and red clover which has been gradually coming in, and during this period the average amount of nitrogen *won from the soil on Plot 68 has been at the rate of 22.6 pounds* per acre, and from Plot 69 at the rate of 19.55 pounds per acre.[1] Alongside of these two plots are two others designated as 70 and 71, which are treated in the same manner except that these have grown on them each year a crop of soybeans to be turned under preceding the seeding of the grain crop, and there, with the aid of the legume crop, the rye on Plot 70 has returned an 8-year average of only 32.6 pounds of nitrogen per acre, and the wheat on Plot 71 only 33.18 pounds per acre.[2] In another section of the same field (same type of soil) are four plots which are planted to corn year after year, rye being seeded each year as a green manure crop at the last cultivation of the corn. Also, these plots have had during the 9 years two or three applications of nitrogenous fertilizers equivalent to about 160 pounds of nitrate of soda per acre, and have had *small* annual applications of farm-yard manure for the introduction of bacteria. With this outside aid the crop has won from the soil an average of only 37.4 pounds of nitrogen per acre for the 9 years.[3] Four other plots adjoining these are treated in the same manner, except that the green manure crop consists of vetch and crimson clover, and with the additional nitrogen thus gained the crops have returned a 9-year average of only 46.54 pounds of nitrogen per acre.[4] *In still another section of the* same field, *two plots which have* received an annual application of 20 pounds of acid phosphate and 10 pounds of muriate of potash, but no nitrogenous fertilizer or green manure crop, and which have been under a 5-year rotation of corn, oats (two years), wheat and timothy, have yielded through the crops, an 8-year average of a little less than 25 pounds of nitrogen per acre.[5]

All of these plots received in 1908 an application of ground limestone amounting to 1 ton per acre, and a further application, in 1913, amounting to 2 tons per acre. They also receive annually an application of acid phosphate and muriate of potash, thus, in this respect, making them comparable with the alfalfa plots.

In the light of the above results, one would naturally conclude that for a soil of the type and quality in question, a non-leguminous crop unaided by

[1] Reports of the department of soil chemistry and bacteriology in N. J. Agr. Exp. Sta. Ann. Rpts. 1912–1915, inclusive.

[2] Loc. cit.

[3] Loc. cit.

[4] Loc. cit.

[5] Lipman, J. G., and Blair, A. W., Field experiments in the availability of nitrogenous fertilizers. N. J. Agr. Exp. Sta. Bul. 260, 33 pp., 4 pl., 1 fig., 1913. Also unpublished results, N. J. Agr. Exp. Sta. 1913 to 1916.

green manures or nitrogenous fertilizers, could not return more than about 25 pounds of nitrogen per acre, and that such crops when aided by a preceding green manure crop or an occasional application of a nitrogenous fertilizer could not recover from the soil more than about 45 or 50 pounds of nitrogen per acre.

But the season's growth of alfalfa, under favorable conditions, has won from the soil or from the air or from both more than 200 pounds of nitrogen. Since it has been shown that under somewhat similar conditions a non-leguminous crop, even with the aid of a preceding legume as green manure, cannot recover from the soil more than about 45 to 50 pounds of nitrogen per acre in a season, it seems a fair conclusion to say that the alfalfa probably secured not less than 150 pounds of its nitrogen from the air.

It might be held that the alfalfa, on account of its long growing season, abstracts more nitrogen from the *soil* than do the non-leguminous crops referred to. If this were true the total amount recovered should decrease from year to year, and likewise the percentage of nitrogen in the dry matter, but, on the contrary, the amount recovered has actually increased for a period of 3 years, as has also the percentage of nitrogen in the dry matter.

While, as already intimated, it is not possible to determine directly just how much nitrogen the alfalfa was able to get from the air, the results as given above seem to justify the assumption that the crop on Plots *G* and *H* in 1916, calculated on the acre basis, secured not less than 150 to 175 pounds of its nitrogen from the air. If the lower figure be taken it would mean nitrogen equivalent to nearly 1,000 pounds of nitrate of soda.

This indicates a plant especially efficient in the accumulation of atmospheric nitrogen, and points to the desirability of a wider use of this crop as a means of maintaining the nitrogen supply of the soil and furnishing a feeding material of high protein content.

Summary

1. The results of 3 years' experimental work on the growing of alfalfa without lime and with different amounts of lime ranging from one-half ton to 2 tons per acre are here presented.

2. Three cuttings were taken each year.

3. For the first year the highest yield was 2¼ tons, with 2 tons of ground limestone per acre; for the second year the highest yield was 3¾ tons, also with 2 tons of limestone, followed closely with a yield of nearly 3 tons on the plot that received limestone at the rate of 1 ton per acre; for the third year the highest yield was slightly above 3¾ tons per acre on the plot that received limestone at the rate of 1 ton per acre, followed closely by the 2-ton plot and the half-ton plot, respectively.

4. On the unlimed plot the yield did not fall below 2 tons nor go much above 2¼ tons. During the second and third years the total yield for the three cuttings increased gradually from the unlimed plot to the plot receiving the most lime, with only one exception. Also, during these two years the

average percentage of nitrogen in the dry matter increased gradually from the no-lime plot to the plot receiving the most lime, with only one exception.

5. The total dry matter and the total nitrogen for each plot increased from the first to the third year.

6. From the plot that received the limestone at the rate of 2 tons per acre there was recovered, in the crop for 1916, a total of 213.41 pounds of nitrogen per acre, and it is estimated, in an indirect way, from data secured from similar plots where non-leguminous crops have been grown, that 150 to 175 pounds of this nitrogen must have been secured from the air.

V

THE INFLUENCE OF LIME UPON THE GROWTH AND NITROGEN CONTENT OF SOYBEANS (VINES AND ROOTS)

In earlier papers[1] attention has been called to the influence of lime upon the growth and nitrogen content of a number of crops, including soybeans, and further data recently secured in experiments with soybeans seem worth recording in this connection.

Six varieties of soybeans, Cloud, Hollybrook, Manchu, Medium Yellow, Ohio 9035, and Swan, were grown on plots that had previously been limed and also on adjoining unlimed plots.

The soil is a gravelly loam of fair quality only. In 1908 the plots designated as the "limed plots" received an application of ground limestone at the rate of 1 ton per acre, and in 1913 a further application at the rate of 2 tons per acre. For a number of years leguminous crops have been grown on these plots, and for the past 3 or 4 years they have been in soybeans. As a result they are well inoculated for this crop. Acid phosphate and muriate of potash are applied annually in order that a deficiency of minerals may not become a limiting factor. The beans were planted May 8 and 9 in rows 33 inches apart. Germination was good, and before the plants were many weeks old there was evidence of good inoculation. The usual cultivation was given.

On August 17 the tops from 4 hills, consisting of 3 plants each, were removed from one of the rows of each variety of the limed and unlimed plots and the roots of each hill were then carefully dug up and a count made of the nodules on each plant. The tops, and roots including nodules, were preserved, dried, weights recorded and finally prepared for analysis. The results thus secured from the 6 varieties are presented in Table VII. The dry weights of tops and roots represent the average of 12 plants.

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[1] Lipman, J. G., Blair, A. W., McLean, H. C., and Merrill, L. F. Report of the soil chemist and bacteriologist. *In* N. J. Agl. Exp. Stat. 34th Ann. Rept. 1913.

Lipman, J. G., Blair, A. W., McLean, H. C., and Wilkins, L. K. Report of the soil chemist and bacteriologist. *In* N. J. Agr. Exp. Sta. 35th Ann. Rept., 1914.

Lipman, J. G., and Blair, A. W. Factors influencing the protein content of soybeans. *In* Soil Sci., v. 1, No. 2, pp. 171–178, 1916.

Blair, A. W., and McLean, H. C. The influence of lime on the yield and nitrogen content of corn. *In* Soil Sci., v. 1, No. 5, pp. 489–504, 3 fig., 1916.

Table VII

Influence of Lime on the Nitrogen Content of Soybeans

VARIETY	Tops Average of 12 Plants						Roots with Nodules Average of 12 Plants								Nitrogen Recovered in One Plant Roots and Tops gm.		Increase in Favor of Lime
	Limed			Unlimed			Limed				Unlimed						
	Dry Matter gm.	Per Cent Nitrogen	Nitrogen gm.	Dry Matter gm.	Per Cent Nitrogen	Nitrogen gm.	Nodules Per Plant	Dry Matter gm.	Per Cent Nitrogen	Nitrogen gm.	Nodules Per Plant	Dry Matter, gm.	Per Cent Nitrogen	Nitrogen gm.	Limed	Unlimed	
Cloud, ...	22.68	2.964	.672	11.34	2.508	.284	29.8	2.542	1.070	.0272	9.4	1.650	1.107	.0183	.6992	.3023	.3969
Hollybrook, ...	18.90	2.991	.565	18.90	2.535	.479	61.2	2.817	1.479	.0417	28.3	2.733	1.274	.0348	.6067	.5138	.0929
Manchu, ...	26.46	3.402	.900	17.01	2.745	.467	82.8	2.600	1.851	.0481	27.0	2.250	1.200	.0270	.9481	.4940	.4541
Medium Yellow, ...	17.01	3.137	.534	15.12	2.544	.385	76.8	2.667	1.284	.0342	52.4	2.158	1.088	.0235	.5682	.4085	.1597
Ohio 9035, ...	22.68	2.745	.623	17.01	2.572	.437	161.9	3.417	1.637	.0550	131.8	3.333	1.312	.0437	.6789	.4807	.1982
Swan, ...	22.68	3.210	.728	11.84	3.092	.351	80.0	2.667	1.479	.0394	50.2	1.875	1.302	.0244	.7674	.3754	.3920
Average, ...	21.74	3.075	.670	15.12	2.668	.401	83.6	2.785	1.467	.0411	50.0	2.333	1.214	.0286	.7114	.4291	.2823

If the dry weights of tops and roots from the limed plots are compared with those from the unlimed plots it will be noted that without exception the former are considerably greater than the latter. The average weight of tops for all varieties on the limed plots is 21.17 gm. per plant, and the average for the unlimed plots is 15.12 gm. per plant. The corresponding weights for the roots are 2.785 gm. and 2.333 gm. Likewise there were more nodules on the roots of every variety from the limed plots than from the unlimed plots, the average for the six varieties being 83.6 nodules per plant for the limed and 50 nodules per plant for the unlimed plots.

Closely associated with these facts is the further fact that with only the exception of the roots from the Cloud, the percentage of nitrogen in the dry matter, both roots and tops, is greater for the limed than for the unlimed plots. The greater number of nodules on roots from the limed plots no doubt explains this. The increased number of nodules would mean better inoculation, and would mean a larger amount of nitrogen taken from the air and therefore more available nitrogen for the plant. As has previously been pointed out, this not only means an increased yield of dry matter, other things being equal, but also higher percentage of nitrogen in the dry matter.

To increase the percentage of nitrogen in a feeding material by means of purchased nitrogen might be a questionable procedure, so far as profit is concerned, but so long as this increase can be at the expense of air nitrogen, it is eminently proper and highly profitable. The nitrogen thus secured goes directly towards the improvement of the soil, or indirectly after first having served its purpose as a feeding material.

To the farmer who grows leguminous green manure crops—and no one should undertake to farm without such crops—the use of lime on soils which are deficient in this material is doubly commended; first, for the increase in the quantity of that crop, and second, for the higher feeding value which the crop thus grown possesses.

VI

THE PROTEIN CONTENT OF SOYBEANS AS INFLUENCED BY ASSOCIATIVE GROWTH WITH A NON-LEGUME

Some of the factors which influence the protein content of soybeans have been discussed in an earlier paper,[1] and the work here reported is a further contribution to that subject.

The experiment was conducted in earthenware pots holding 20 pounds of a brownish-red sand which contained only 0.03 per cent nitrogen. All pots were given 4 gm. of acid phosphate, 2 gm. of potassium sulfate, 10 gm. of ground limestone, and $^2/_3$ gm. of nitrate of soda. The small amount of nitrate was used in order that the young plants might have available nitrogen in the event that inoculation should be delayed. These materials were thoroughly mixed with the soil before the seeds were planted. Where

[1] N. J. Agr. Exp. Sta., 35th Ann. Rept., 1914.

the two crops grew together the non-legume was planted around the outer edge of the pot in order that it might not be shaded by the soybeans. The pots were inoculated by sprinkling with an infusion made with soil taken from a plot where soybeans had grown. As the plants grew the color indicated good inoculation. This was later confirmed by the abundance of nodules on the roots at the time of harvesting. The crop was harvested August 25, before the leaves had fallen, but after the pods were well filled. The number of seeds planted per pot, the yield of dry matter, the percentage of nitrogen in the dry matter and the total nitrogen recovered are indicated in Table VIII.

Table VIII

The Protein Content of Soybeans Grown in Association with Non-Legumes

	CROP	Dry Matter, gm.		Per Cent Nitrogen		Nitrogen, gm.		Total Nitrogen, gm.
		Legume	Non-Legume	Legume	Non-Legume	Legume	Non-Legume	
1	16 Soybean Seeds, ...	28.1	....	1.879	....	.528	....	.528
2		28.4	....	1.970	....	.559	....	.559
15		27.7	....	2.143	....	.594	....	.594
16		27.8	....	1.924	....	.535	....	.535
3	24 Buchwheat Seeds,	....	6.5	....	0.593	....	.0385	.0385
4		....	4.8	....	0.648	....	.0311	.0311
5	8 Soybean and	14.7	3.5	2.052	0.565	.302	.0198	.3218
6	16 Buchwheat Seeds,	13.0	4.0	2.034	0.766	.264	.0306	.2946
7	24 Barley Seeds, ...	....	7.0	....	1.004	....	.0766	.0766
8		....	6.2	....	0.985	....	.0611	.0611
9	8 Soybean and	14.3	6.0	2.180	0.985	.312	.0591	.3711
10	16 Barley Seeds, ...	14.4	5.1	2.043	0.857	.294	.0437	.3377
11	24 Oat Seeds, ...	....	6.5	....	0.876	....	.0569	.0569
12		....	6.2	....	0.775	....	.0481	.0481
13	8 Soybean and	16.7	3.9	1.933	0.739	.323	.0288	.3518
14	16 Oat Seeds, ...	14.7	3.8	2.180	0.948	.320	.0360	.3560

When the legumes and non-legumes are grown separately the yields of the former are much the larger under the same conditions. Thus the average for the soybeans alone is about 28 gm. per pot, while the average for the non-legumes is only a little more than 6 gm. per pot. Where the two are grown in association the yield of the soybeans is slightly more than half the yield where these were grown alone, and the yield of the non-legume is considerably more than half the yield where this was grown alone. Thus the average weight of all non-legumes grown alone was 6.2 gm., while the average weight of all those grown in association with the soybeans is 4.385 gm., which, it will be noted, is distinctly more than half the weight where they were grown alone. The average percentage of nitrogen in the dry matter of the legume grown in association with the non-legume is slightly higher than the average in the dry matter of those grown alone.

Likewise the percentage of nitrogen in the dry matter of the non-legume grown in association with the legume, with the possible exception of the barley, does not suffer any depression as compared with the same crop grown alone.

The average amount of nitrogen recovered by one of the crops growing in association with the other is slightly more than one-half the amount recovered by that same crop grown alone. For example, the average amount recovered by the non-legumes growing in association with the soybeans is 0.0363 gm., while the average amount recovered by the non-legumes growing alone is 0.052 gm.; the average amount recovered by the soybeans growing in association with the non-legumes is 0.302 gm., while the average amount recovered by the soybeans growing alone is 0.554 gm.

No claim is made for the correctness of the proportion of seeds used where the crops are grown in association as compared with the numbers where they are grown alone. The numbers are entirely arbitrary. Different proportions might give different results, but for the proportions used, it appears that the protein content of soybeans grown in association with a non-legume is slightly greater than when grown alone, and that the protein content of two out of the three non-legumes is likewise slightly increased under the same conditions.

The yield of dry matter from the soybeans alone is decidedly larger than the combined yield when these are grown in association with a non-legume.

DEPARTMENT OF BIOLOGY

Department of Biology

* Thurlow C. Nelson, B.Sc., *Assistant Biologist.*
* P. Calydon Cameron, *Laboratory Assistant.*

* Temporary appointments for summer field work.

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Report of the Assistant Biologist

THURLOW C. NELSON

I

INTRODUCTION

Summary of the Contributions of the Late Julius Nelson, Ph.D., Biologist of the New Jersey Agricultural Experiment Station from 1888 to 1916, to Our Knowledge of Experimental Oyster Culture

On February 15, 1916, the Experiment Station lost, through the death of Dr. Julius Nelson, a biologist of 27 years of active service. At the same time the scientific world sustained the loss of its foremost investigator in experimental oyster culture. As a son and pupil of the deceased, the writer wishes to sketch briefly the history of the development of scientific oyster investigation in New Jersey from its beginning, as embodied in the work of the biologist.

Dr. Nelson was called to Rutgers College as Professor of Biology in 1888. He at once became identified with the Experiment Station, and at the suggestion of the director began an investigation of the existing conditions in the oyster industry of the State.

In his report for that year the status of the industry is fully set forth, showing that an annual income of about $2,000,000 was realized, and that approximately 60,000 persons were employed.

In the next year, 1889, active duties were begun in the field. A claire was constructed at Keyport, N. J., and attempts were made to rear oyster larvæ artificially from the eggs. The report for this year gives a good summary of all previous attempts to rear oysters by artificial means, as well as a survey of the literature on the subject.

The extent and scope of the experiments were increased during the next year, and many tests were made with artificial sea water in its effects upon the oyster eggs. Special attention was given to the pathological changes observed in the eggs when under adverse conditions.

The season of 1891 was spent largely in preparing an oyster exhibit as part of the Coöperative Exhibit of Experiment Stations in the Columbian Exposition at Chicago. Many charts and preserved specimens were included in the exhibit. In addition, observations were made of the methods of practical oyster culture as practiced in the waters of Long Island Sound and of Virginia. Claires were constructed in New Jersey in which artificially reared oyster larvæ were planted. No positive results were obtained.

During the summer of 1892 the experiments in artificial propagation were continued. In addition, the biologist was called upon to investigate the cause of "greening" in clams at Tuckerton, N. J.

The next eight years found the biologist concerned with investigations of the spread and diagnosis of bovine tuberculosis with relation to the prevalence of human tuberculosis. During this time, for obvious reasons, the work in experimental oyster culture was at a standstill.

The year 1900 witnessed the beginning of a series of observations and experiments by the biologist which were continued without interruption up to the time of his death. The results of these sixteen years of study represent an achievement which has rarely been equalled in the field of ecological research. It would transcend the limits of this report to mention more than very briefly the fundamental facts in the life-history of the oyster discovered during this period. The field of observations was confined largely to Barnegat and Tuckerton, New Jersey. Permanent laboratories were erected at both points, with temporary stations at Scullville, on the Great Egg Harbor River, and at Keyport, on Raritan Bay.

The work of the season of 1900 dealt mainly with the anatomy and biology of the oyster. The report for that year contains also a discussion of the causes for the destruction of the natural reefs, and means of restoring them. Further experiments in artificial propagation were carried on during that year.

As a natural outgrowth of the work of the previous year the investigations in 1901 dealt with the phenomena of fertilization and early development of the oyster egg. The report is well illustrated with many drawings made from the living material.

The later development of the oyster embryo was studied during the following summer. The report for that year shows the successive stages in development up until the time the oyster embryo becomes a shelled swimming larva. Observations were made on the food and enemies of the oyster.

The summer of 1903 found the biologist still struggling with the problem of artificial propagation. Many experiments were conducted to determine the optimum conditions as regards food and oxygen required by the developing oyster. Description and drawings are given of the Bucephalus parasite often found in the gonads of mature oysters.

Still continuing in his quest for some means of rearing the oyster larvæ artificially, the biologist during the next year constructed floats covered with fine cloth. These, however, were found to be inadequate to hold the young oysters. During the same season a series of studies of the histology or microscopic study of the tissues of the oyster was undertaken. The report for that year contains many plates illustrating the text, drawn by the author.

With the summer of 1905 came a further development in the use of floating boxes in which the oyster larvæ were kept. Although the young oysters were able to live under these conditions, they never attached themselves to the experimental cultch provided. Experiments were made with the use of various substances as cultch on the natural grounds. In addition, the problem of the genesis of oyster spawn was studied in detail in fixed and stained material.

During the next season the biologist directed his chief attention to the natural setting or "spatting" of the oysters. Many oyster larvæ were reared artificially through the early stages of development.

The year 1907 marked the beginning of a new period in the investigations of the biologist. Through an increased appropriation a suitable power-boat was constructed, thus giving a ready means of access to oyster growing regions formerly inaccessible.

The biologist had, for several years, been filtering the water of the open bays and creeks to find the young oysters in their natural state. From his observations during this season he gained the important fact that the free-swimming, larval stage in the life of the oyster may extend from one to three weeks. An attempt was made during this season to predict, from the stage of development of the larvæ, when shells should be placed on the beds in order to obtain the best "set." The report for this year shows in a series of accurate drawings the method of attachment of the young oyster to the cultch, and the subsequent laying down of the adult shell.

Beginning with the summer of 1908 the writer became identified with the work as laboratory assistant, thus relieving the biologist of many minor duties. Two important conclusions

resulted from that season's studies: 1. At a temperature of 70 to 75° F. the oyster larvæ come to the setting stage in about three weeks. At a temperature of 75 to 80° F. this period is shortened nearly a week. 2. Observations of the distribution of the oyster larvæ with respect to salinity showed that the young oysters are seldom found in water of less density than 1008. The usual experiments in artificial propagation were continued.

The studies of 1909 were concerned mainly with the effect of climatic conditions on the life and movements of the larvæ. A well-equipped floating laboratory was built during that year.

In the fall of the same year the biologist was called to Maurice River Cove to investigate the causes of mortality among oysters there. Shifting sands, which smothered the shellfish, were found to be the cause.

The observations of the relation between the climatological conditions and the numbers and growth of the larvæ were carried out in even more detail during the summer of 1910.

In the spring of that year the biologist was called upon to give expert testimony before the National Board of Food and Drug Inspection, in connection with the floating of oysters. Largely through his efforts a measure was finally passed, which, while satisfying the oyster growers, still guarantees a measure of safety to the consumer.

The summer of 1911 found the biologist still watching closely the reactions of the larvæ to external conditions. Further observations were made regarding the distribution of the young oysters in relation to tides and currents.

Experimental oyster culture received a further impetus in 1912, when two branch stations were established under the supervision of the biologist. The problem set before all the investigators was that of amassing data which should give a deeper insight into the relation between the oyster larva and its environment. The same work was continued at the three stations the next summer.

In 1914 a beginning was made in gathering together specimens for a museum of natural history of the oyster. This year furnished opportunity also for an expansion of interests on the part of both the biologist and the assistant biologist. At the close of the summer Dr. Nelson, at the invitation of the Biological Board of Canada, gave a series of lectures at points in the oyster producing regions of Prince Edward Island, Canada. The lectures were popular and educational in nature.

The writer answered a summons that year from the United States Fish Commission to go to southern Alabama and investigate there the causes of a great mortality among the oysters.

The next year witnessed the final triumph of the biologist. The faithful work of many years was bearing fruit, and others trained by him were carrying on the investigations. After a month of most profitable investigation of the reactions of the oyster larvæ under natural conditions, Dr. Nelson went to Prince Edward Island to undertake a survey for the Biological Board. There the remainder of the summer was spent studying the distribution of the oyster larvæ in Richmond Bay. The report of this survey is to be found in the "Contributions to Canadian Biology" for the following year. This, the last work of Dr. Nelson, forms a fitting climax to a long and most useful career in scientific research.

Scope of the Investigations of the Season

In the report of the previous year further facts are set forth showing the reactions of the natural oyster larvæ to their environment. The direct effect of warmer temperatures in shortening the length of larval life was more clearly demonstrated. Important observations are recorded of the relation of certain enemies to both the larva and adult.

The task of the present season in general has been twofold. First, what determines the position of a natural oyster reef, and why are some planted beds so much better for "spatting" than others, perhaps nearby? May the distribution of the oyster larvæ in the water be a determining factor in this case? Second, is it possible by noting the stage of development of the oyster larvæ to predict with any degree of certainty when a set will occur, and plant cultch accordingly?

It may be said in partial anticipation of what follows that as a result of the season's investigations a tentative answer to the first question has been obtained. With respect to the second of these problems a more definite answer can be given. With the technique now developed it has been possible to predict within two days the time the oyster larvæ set.

During the summer notices were posted in the town of Tuckerton giving the numbers and stage of development of the young oysters in Little Egg Harbor. On July 16 a statement was posted with the information that a set was to be expected within a week or 10 days, and to get shells ready to go overboard. On the following Saturday, the twenty-second, notice was given to expect a set within two days at the most. Experimental shells placed early that morning showed that setting began during the night of the twenty-second or morning of the

twenty-third, and was still going on when the shells were removed on the twenty-fourth.

In addition to the above, some observations were made on the mode of locomotion of the oyster larva. Important facts were obtained regarding the food and feeding habits of the adult oyster. Finally, a good beginning was made in preparing an oyster museum as a part of the educational exhibit planned, and partially executed, by Dr. Nelson in the last years of his work. This museum is located in the basement of New Jersey Hall. Visitors are welcome at all times when the building is open.

II

STATIONS AND ASSISTANTS

Our studies of scientific oyster propagation for the season of 1916 were confined to the stations at Barnegat and Tuckerton. The investigations at Barnegat were carried on, as last year, by P. C. Cameron, of Philadelphia.

The central station was in charge of the assistant biologist, who was located at Edge Cove, Tuckerton, N. J. During the months of July and August the services of J. Richards Nelson were secured as first assistant at the Tuckerton station.

III

CLIMATIC CONDITIONS

The summer of 1916, as a whole, has been very favorable for the carrying on of our experiments. No hard thunder storms occurred at the Tuckerton station, but few at Barnegat, and the winds, though persistent, were seldom of such force as to interfere materially with the daily routine.

The spring was unusually backward. We learn from the Climatological Data of the United States Weather Bureau for New Jersey that the cold of March was almost unprecedented. The month of April, cold throughout the State, averaged 48.5° F. at Tuckerton, or 0.6° above the normal. The precipitation was 2.61 inches, or 1.18 inches below normal. The prevailing winds were northeast.

May, though warmer, did not afford sufficient warm days to overcome the backwardness of the season. The mean monthly temperature at Tuckerton was 61.8° F., 2.1° above normal. The rainfall was 3.87 inches, or 0.44 inches above normal. The prevailing winds were northwest.

The month of June was unusually cold throughout the State, with two exceptions the coldest on record for 23 years. At

Tuckerton the mean temperature was 65.0° F., or 4.0° below normal. The precipitation was 4.22 inches, or 0.45 above the normal. Warm spells occurred on June 16 to 26, inclusive, and on the last three days of the month. The prevailing winds were southeast.

As the investigator was absent from the Edge Cove station from June 1 to 4, and 11 to 13, inclusive, the weather records are given from the reports of the station of the Weather Bureau at Tuckerton, located a mile and a half inland from the cove. The records as given for July and August are from our own observations.

July was nearly normal, but excessively humid. The monthly mean temperature at Edge Cove was 73.1° F., or 1.7° below that reported for the Tuckerton station of the Weather Bureau. The rainfall was 5.03 inches, or 1.73 inches below that reported inland. Warm spells occurred on July 3, 7 to 9, 12 to 14, and 31. The prevailing winds were southwest.

August was warmer than usual, and exceptionally dry. The mean temperature at Edge Cove was 73.3° F., or 0.5° below that reported inland. The rainfall for the month was 1.85 inches, or 0.24 inches above that for the Tuckerton station. The latter record falls 4.17 inches below the normal for the month. Warm spells occurred on August 1, 6 to 9, 12, 21 to 23, and 25. The prevailing winds were southeast.

IV

WATER CONDITIONS

Owing to the backwardness of the season the water during early June was somewhat colder than usual. At Barnegat the monthly mean was 68.5° F., with a range from 60.0° on the ninth, to 74.6° on the twenty-sixth. The mean salinity was 10,135 ranging from 10,105 on the fourteenth, to 10,170 on the seventh.

At Tuckerton the general waters of the bay showed a mean temperature of 71.0° F. The lowest temperature recorded was 60.0° on the tenth. The highest was 78.0° on the twentieth. The mean salinity was 10,182, ranging from 10,105 on the twenty-second, to 10,200 on the eighth.

For July the water at Barnegat showed a mean temperature of 78.7° F., with extremes of 72.0° on the fifth, to 84.0° on the eighteenth. The mean monthly salinity was 10,130, ranging from 10,030 on the twenty-third, to 10,170 on the twentieth.

At Tuckerton the mean monthly temperature of the water was 77.2° F., the highest temperature recorded being 85.0° on the third. The lowest was 70.0° on the sixth. The mean salinity was 10,175, ranging from 10,135 on the twenty-second, to 10,200 on the twelfth.

During August the temperature of the Barnegat waters averaged 77.5° F., the highest recorded being 85.0° on the seventh. The lowest was 72.0° on the thirteenth and sixteenth. The mean salinity was 10,147, ranging from 10,090 on the twelfth, to 10170 on the thirtieth.

At Tuckerton the mean temperature of the water for the month was 78.2° F., with the extremes of 70.0° on the fourteenth, and 86.0° on the eighth. The mean salinity was 10184, ranging from 10,155 on the second, to 10,205 on the fourteenth.

In addition to the above, records were kept of the temperature and salinity of the water passing the Cynthia at the mouth of Huey's Creek. For July the mean temperature of this tidal water was 77.9° F., with a range from 89.0° at low water on the thirteenth, to 69.0° at low water on the morning of the sixth. The mean salinity was 10,163, ranging from 10,055 at low water on the fourteenth, after a heavy shower, to 10,190 at high water on the fourth, sixth and ninth.

For August the temperature of the water here averaged 78.2° F., the same as the general bay, with extremes of 86.0° on the eighth, ninth and twenty-third, and 68.0° on the fourteenth. The mean salinity was 10,182, ranging from 10,150 on August 1 and 4, to 10,200 on August 14, 15, 17, 20 and 21.

The averages for the Barnegat Station are based upon 206 temperature readings and the same number of salinity readings. At Tuckerton a total of 557 determinations of salinity and of temperature were made.

V

SPAWNING DATA

One of the drawbacks of former seasons has been that few, if any, observations were made prior to the early part of June. By this time the oysters have usually begun spawning, and consequently we have had little bearing on the inception of the spawning process. During the past season some knowledge of this was gained through oysters sent to the writer at Madison, Wisconsin. Through the coöperation of the Ezra Stiles Co. at Tuckerton, New Jersey, oysters were taken from the beds and,

without floating, were sent at once to their destination. After about two days they arrived with the hearts beating, and showing the mantle and adductor muscle very responsive when stimulated. Frequently oyster crabs (*Plinnixa, sp.*) were encountered within the branchial chamber, and these were invariably alive.

The first shipment arrived in Madison on March 28. They were examined at once and revealed no signs of the sexual products. Smear preparations examined microscopically showed that the sex cells had not yet begun active proliferation.

The next shipment was received on April 19. Out of a dozen individuals examined, one showed the tubules of the gonad much swollen with spawn. In the others the tubules were just beginning to be visible to the naked eye.

A third lot came about May 20, but owing to hot weather at the time, these oysters were not in as good condition as the earlier shipments. Those individuals examined showed further development of the gonads.

On June 5 observations were begun at Tuckerton. Out of 60 individuals examined at that time only one showed no spawn present. Of the remainder, 37 were immature and the rest ripe.

By the middle of June most of the oysters were fairly ripe, and many were slowly throwing out their spawn. On July 1 one-seventh of those examined were nearly spawned out, while others were ripe and had not yet begun to throw out their spawn. Natural stock, taken at Rose's Point, and known as early spawners, were completely spawned out by this time.

On July 27 seven-eighths of the oysters taken at the Cynthia were practically spawned out. Oysters taken in the bay seemed to be holding their spawn longer than those in Huey's Creek.

Oysters opened on August 8 showed almost all the spawn thrown out. On this date, also, many oyster larvæ were present in the water, as may be seen in the following section.

When observations were closed at the end of the month, the oysters on some of the beds in Huey's Creek still showed considerable spawn.

Observations this past season, together with those of former years, tend to show that there is considerable difference in the time of spawning of the oyster on the different beds. Natural stock always spawns before that from farther south, but there are other factors operating in a large measure to affect this process. We hope to give this problem special attention during the following season.

VI

FURTHER STUDIES OF THE GROWTH AND DISTRIBUTION OF THE OYSTER LARVÆ

Scope and Methods of the Investigations

The work of the present season consisted chiefly of carrying on the experiments of former years. At Barnegat intensive studies were made of the growth and variability in numbers of the oyster larvæ as influenced by environmental conditions.

At Tuckerton the observations were extended so as to follow the distribution of the oyster larvæ over wide areas. Heretofore our observations at Tuckerton were confined largely to Edge Cove and the creeks entering it.

This year observation stations were established at the following points as shown on the map: 1, The northern point at the mouth of Edge Cove; 2, the mouth of Thompson's Creek; 3, mouth of Middle Creek; 4, at the head of Rose's Cove; 5, at Rose's Point; 6, at the mouth of Parker Run; 7 and 8, at the mouths of large tidal creeks entering on the north shore at Parker Cove; 9, at the Long Point Thorofare in deep water; 10, in the mouth of Parker Cove; 11, in the middle of Little Egg Harbor, midway between Edge Cove and Beach Haven Channel; 12, at the edge of the flats to the north of Johnny Sedge; 13, midway between Shellir and Barrell Islands, at the south side of channel to Beach Haven, and 14, at the edge of grass flats west of Shellir Island. Occasional observations were made in addition at Jeremy's Point, Gaunt's Point, and at points in Gaunt's Cove.

In the collection of water samples at these stations during the summer, over 300 miles were covered in the station launch, Novia; 440 specific gravity readings, and the same number of temperature readings were taken.

The method of procuring water samples was as follows: A small plankton net of the finest bolting cloth was hung over the side of the boat by a ring, with the mouth of a large funnel inserted in the top of the net. With as little disturbance as possible, a 12-quart pail of water was dipped up and poured through the funnel into the net. In the bottom of the net was fitted a glass vial, the bottom of which had been replaced by a cork. When the water had passed through the net it was lifted into the boat, and with a stream of water from a large pipette the sediment was washed down into the vial. The cork was then removed and the whole washed into a tumbler. This sample

was afterwards numbered and a little formalin added to preserve it.

Samples of from 12 to 60 quarts were taken, depending on the amount of sediment in the water and the abundance of the larvæ.

The use of the plankton net greatly hastens the work of obtaining water samples, without materially affecting the accuracy of the count as obtained by the settling method of former years. Its use was suggested by the work of Stafford, 1913, who made extensive use of it in his qualitative studies of oyster and other bivalve larvæ in Canadian waters.

Plankton Studies

The Barnegat Station

Field observations were begun on June 5, at which time oyster larvæ a week old were in the water, together with many larvæ of the clam, *Venus mercenaria*. For the next 16 days oyster larvæ were always present in the water, but at no time did they reach 100 per 12-quart sample.

On June 21 the number rose to 300 per sample in the water of the creek. During the next three days most of these disappeared, to be followed on the twenty-eighth by a sudden increase to 10,000 larvæ per 12 quarts.

A large number of the larvæ in this sample had not yet reached the shell stage, many were but swimming blastulæ. These were kept in the laboratory for several days and during that time many developed shells. This observation is of value since it tends to substantiate certain conclusions based upon our experiments in artificial propagation, namely, that given ripe eggs, properly fertilized, healthy larvæ will develop beyond the shell stage even under laboratory conditions.

Oyster larvæ continued in abundance on the twenty-ninth and thirtieth, and the first three days in July, after which there was a rapid falling off in their numbers.

Little spawning occurred after this until July 18, when the numbers rose to 459 per sample, and again on July 22, when 260 were recorded. By the following day the larvæ had practically disappeared, and at no time during the rest of the month were there more than 40 to a sample.

From August 1 to 7 there was a steady increase of larvæ. This was followed by a slight decrease on the eighth and ninth. On the tenth the numbers rose to 900 per sample, but by the next day these had almost disappeared. For the rest of the

month a few larvæ were present in the water on each day except August 17, 23, 27, and 29.

In all, 206 water samples were examined, and the same number of salinity and temperature readings taken.

The investigator at the Barnegat Station carried on the investigations during September, and was still making observations as this report went to press.

Throughout this period oyster larvæ were present in the water. On October 12, the last date of which we have record, there were 440 larvæ per 12-quart sample in Barnegat Bay.

The water conditions during this period are of great interest in connection with the presence of the oyster larvæ. The temperature varied from 38 to 60° F., while the salinity rose to the unusual heights of 10,200 and 10,205.

These post-seasonal observations made by Mr. Cameron are of great interest, as they demonstrate that oyster larvæ can develop and grow at temperatures from 10 to 30 degrees colder than those prevailing during the summer spawning period.

The Tuckerton Station

As at Barnegat, oyster larvæ were present in the water of Little Egg Harbor when observations were begun on June 5. These were from several days to a week old. During the next two weeks a few larvæ were present in the water at all times. On the nineteenth one large larva was found, and on the twenty-first three, of which one was ready to set.

The first period of active spawning occurred on June 23, when the number rose to 178 per sample, most of which were in the early shell stage. A few large larvæ nearing the setting stage were present also. A second and less extensive spawning occurred on the thirtieth, at which time large larvæ, ready to set, were found in the samples from all the observation stations visited.

Examination of figure 5 shows that during July spawning was fairly general, but at no time did it reach large proportions. Periods of increased spawning occurred on July 10, 14, 18 to 20, and 30.

The principal spawning of the season occurred during August. On the third 550 larvæ per sample were recorded, and on the eighth 900. This was followed by a rapid decrease in numbers, so that by the sixteenth less than 100 were found. The prevalence of large oyster larvæ during most of July and August is very significant, as it is the presence of these, rather than the younger stages, which indicate an impending set. Reference to

figures 5 and 6, show that there were few days on which these large larvæ were not to be found.

Distribution of the Oyster Larvæ

From the data collected at the fourteen observation stations in Little Egg Harbor important conclusions may be drawn as to the mass movements of the oyster larvæ.

Starting at the mouth of Edge Cove and running northeast to Parker Run, it was found that the larvæ in general became continually more numerous as we went up the bay. Leaving Station 6, at the mouth of Parker Run, and traveling southeast to Long Point, there was almost always a marked falling off in the number of larvæ to be found. So consistent was this decrease in the numbers, especially at Stations 7 and 8, that these points were finally abandoned save for an occasional observation. At Station 9, in the Long Point thorofare, the oyster larvæ were never as plentiful as at the stations along the mainland, regardless of the state of tide and other conditions.

During ebb tide the water runs from east to west through this thorofare, bringing down the waters off West Creek and Cedar Run. With the flow the current comes north-northwest up the Beach Haven Channel, and swinging westward passes along the southern shore of Long Point. A portion of this water spreads out across the bay towards the mainland, the rest, turning northward around the western end of Long Point, passes eastward through the southern half of the thorofare.

At the same time water from Parker Cove passes through the thorofare on the northern side of the channel. A distinct tidal slick can be seen where the two bodies of water are in contact, and sharp differences in temperature and salinity were observed in the water on either side of this line.

The result of this movement of the tidal waters is to cause more or less backing up of the water in Parker Cove, so that there is little mixing with the incoming tide. The distribution of the oyster over this region follows the currents as given above. In samples taken in the middle of Parker Run, over the spot once occupied by a natural oyster reef, we have found large numbers of larvæ, while the water flowing through the Long Point Thorofare eastward showed very few.

Table I gives the number of oyster larvæ in 24 quarts of water taken at the various observation stations during a 12-day period during the spawning season. Note how the totals for the stations increases from Stations 1 to 6, and then drops off markedly at Station 9.

Table I

Numbers of Oyster Larvæ in Samples Taken at Various Stations Over a 12-Day Period

	1 Edge Cove	3 Middle Creek	4 Rose's Cove	5 Rose's Point	6 Parker Run	9 Long Point
	166	77	8	50	10	16
	1,588	230	1,100	390	4,120	90
	340	1,470	390	590	90	20
	43	30	49	142	67	66
	44	3	69	35	167	1
	4	727	24	71	138	133
	189	404	1,200	1,740	1,076	133
	206	307	458	441	196	71
	145	173	87	279	523	31
	35	176	269	177	188	5
	78	18	95	186	39	55
	85	159	333	8	102	...
Total,	2,923	3,576	4,082	4,109	6,696	521

What, then, are the limits of distribution of the oyster larvæ in the region under consideration? How far are they carried by the tides?

On July 13 we left Edge Cove at 8.20 A. M., on the turn of the flood tide. This was at a time of alternate spring and neap tides, and, being the morning tide, was only about half as high as the one which followed it. Station 1 showed 564 larvæ to 60 quarts of water; Station 3 had 3,600; and Station 6, 1,600 larvæ. Station 12 was reached at 10.20 A. M., by which time the tide had fallen nearly half, as shown by the Edge Cove tidal record. A 60-quart sample taken here gave only 36 oyster larvæ. Station 13, ten minutes later, gave 563, and Station 11, half an hour after, had 130.

Stations 11 and 13 lie in the direct course of the tidal currents of the bay, and yet they showed at ebb tide much fewer larvæ than the stations in the upper part of Little Egg Harbor. Station 12 is out of the direct course of the main currents, and gave but a very few larvæ.

On the next day the above course was repeated. Station 1 gave 1,500, 3 had 1,100, while 6 showed 4,120. Going at once to the opposite side of the bay and taking samples of the outgoing water revealed 212 larvæ at Station 13, and only 34 at Station 14.

Again on July 22 this course was repeated just before dead low water. Station 1 had 18, 3 had 18, and 6 had 6. Station 13 was reached at dead low water and revealed 148 oyster larvæ. The tide having fallen to its lowest ebb the larvæ were all well over toward the eastern half of the bay.

On August 19 the stations gave the following significant figures, in 12 quarts of water:

1	2	3	4	5	6	9	11	13	14
206	119	307	458	441	195	71	510	36	14

The sample at Station 1 was taken at about half ebb, on the neap tide. The samples at Stations 13 and 14 were taken an hour and a half before low water. The sample at 11 was procured an hour prior to low water. Notice that the great mass of oyster larvæ had reached the middle of the bay by this time, but that half an hour earlier they were hardly apparent at the Entrance to the Beach Haven Channel.

On August 14, at a time of even tides, this same route was covered, beginning two and a half hours before the full flood tide. Below is given the number of larvæ found in 24 quarts of water:

1	3	4	5	6	9	10	12	13	14
85	159	333	8	202	55	271	32	122	84

The samples at Stations 12, 13 and 14 were taken an hour before full flood, and show that, though in reduced numbers, the larvæ were still present in this part of the bay, as the tide was nearing the full flood.

Extending the survey to the extreme eastern part of the bay, in the channel along the beach, it was found that larvæ were present in the water south of Beach Haven an hour before low water.

Observations at the regular stations were made every day during the spawning period, weather permitting. We have given above only a few of the more striking examples. The summary of the data collected is to be found in the account of water conditions, given above, and in figures 4 to 6, inclusive.

Distribution of Oyster Larvæ in Waters Leading to the Inlet

On July 25 a run was made from Edge Cove to Little Egg Inlet, water samples being taken on the way. The tide was just beginning to fall. The points passed, with the temperature and salinity of the water, and number of larvæ present, were as follows:

Station 1, 10,170 at 79.0° F., 198 larvæ; Oyster Point, 10,170 at 79.0°, 2 larvæ; southeast of Parker Island, at the entrance to Marchelder Channel, 10,170 at 79.0°, 0 larvæ; halfway to Short Beach Light, in the middle of the channel, 10,185 at 78.0°, 3 larvæ; off the Short Beach Light, below the junction with the Beach Haven Channel, 10,190 at 77.0°, 0 larvæ.

The mouth of the Inlet was reached about an hour and a half before slack water. A sample at the surface gave 10,175 at 77° F., 37 larvæ; at a depth of 12 feet, 10,185 at 77°, 35 larvæ, of which 6 were large and ready to set.

Samples were taken after the tide had risen for about an hour. The surface water showed 10,190 at 76.0°, and 34 larvæ; at a depth of 10 feet, 10,200 at 74.0°.

Two days later this course was repeated with similar results. This time, however, the return trip was made westward through Shooting Thorofare to Seven Islands, and up the Crab Island Thorofare to Great Bay. Examination of the water over this route gave the following results: Inlet, tide early ebb, 10,205 at 75.0° F., 8 larvæ; east of Little Anchoring Island, at the edge of deep water, 10,185 at 78.0°, 36 larvæ; channel, south of west end of Anchoring Island, 10,170 at 79.0°, 60 larvæ; in the thorofare at the southeast end of Crab Island, 10,145 at 80°, 42 larvæ; at the western end of this thorofare, 10,135 at 81.0°, 178 larvæ; at the eastern end of Crab Island, 10,140 at 81.0°, 12 larvæ; in the Great Bay entrance to this channel, at dead low water, 10,125 at 81.0°, 70 larvæ, of which 2 were ready to set.

It is important to note that as we near the Inlet, coming south in Marchelder Channel on ebb tide, the water becomes of greater density, and few or no larvæ are present, until we reach the Inlet. Here the influence of the water from Great Bay at once becomes manifest in the sudden lowering of salinity, and in the presence of oyster larvæ.

Summary of Distribution and Conclusions

At ebb tide the water on the western side of Little Egg Harbor sets in a southwesterly direction, and follows the shore from Parker Cove to Oyster Point. Here it swings southeast, and passes out the main channel to the Inlet through Marchelder Channel, and the passages lying between the islands north of Story Island.

The water in the upper and eastern part of the bay takes chiefly an easterly and southeasterly direction, passing through the Beach Haven Channel, and following the beach enters the main channel north of Tucker's Island. During the flood tide the direction is, in general, reversed.

As the principal oyster beds lie on the western half of Little Egg Harbor, the larvæ tend to be most numerous close to the mainland, following the ebb and flow of the tide parallel to the shore. Situated as it is, some distance from the Inlet, Lit-

the Egg Harbor forms a sort of natural trap, from which the oyster larvæ would escape only on very low tides.

Great Bay, on the other hand, is situated much closer to the Inlet, and as a result many oyster larvæ pass out to sea with every outgoing tide.

Formerly we have always supposed that when the oyster larvæ are carried out to sea they are irrevocably lost. Our observations given above show that even an hour after the flood tide has commenced, living larvæ are returning from the sea, and in water which has no higher salinity that that often found at times in Edge Cove. It will be remembered that the larvæ were near the surface, while at a depth of 10 feet the water was much heavier, and no larvæ were present.

We must conclude, therefore, that the water in at least the last portion of the outgoing tide at Little Egg Inlet, maintains its identity out in the ocean, and returns through the Inlet at the beginning of the flood, without having mixed appreciably with the briny sea water. Provided with a suitable boat, it is our intention to follow the larvæ out to sea at ebb tide, and find the limits of their distribution there.

Observations at Great Bay and Mullica River

The close attention paid to the regular observation stations in Little Egg Harbor prevented us from making as many observations in the Great Bay region as usual. The results of the three trips made were as follows:

On June 27 the mouth of the Mullica was reached, where the following observations were taken: north shore on mid-ebb tide, 10,150 at 72.0° F.; half an hour later on the gravellings off Turtle Island, 10,140 at 73.0°, 26 larvæ; over the middle of the gravellings 15 minutes later, 10,130 at 72.0°, 38 larvæ, of which three were large, and one was ready to set; beyond the outer edge of the gravelling, near the middle of the river 10,120 at 73.0°, 17 larvæ; at the south shore of the river, in very rapid current, 10,115 at 73.0°, 10 small larvæ.

On July 18 the following course was covered: west end of Crab Island Thorofare, tide just commencing to flow, 10,165 at 76.0° F., 22 larvæ; mouth of the Mullica, north shore, half an hour later, 10,145, 14 larvæ; south shore of the river 10 minutes after, 10,110 at 78.0°, 6 larvæ; middle of the river, 10,115 at 78.0°, 6 larvæ; on the gravelling 5 minutes later, 10,125 at 78.0°, 38 larvæ. After the tide had risen for one hour the same course was repeated: south shore, 10,125 at 78.0° F., 4

larvæ; middle of the river, 10,120 at 78.0°, 6 larvæ; gravelling, 10,140 at 78.0°, 8 larvæ.

The last observations made in Great Bay were on July 27, on the return trip from the Inlet. At the west end of Crab Island Thorofare at dead low water, a sample taken showed 10,125, 70 larvæ, of which 2 were ready to set.

The above data, though scanty, tend to substantiate our findings in Little Egg Harbor. The observations given above show that the water over the gravelling registered as much as 2.5 points higher salinity than that on the south side of the river. In all cases more oyster larvæ were taken over this natural bed than on the opposite side.

It appears, therefore, that the fresher water tends to pass to the south of the gravelling, while the saltier water of Great Bay, containing more oyster larvæ, passes on flood tide over the region once occupied by a great natural oyster reef. This behavior of the currents may account in part for the presence of the once great natural growth on the gravelling; during times of freshet the water of highest salinity would naturally occur here.

As a final conclusion regarding the distribution of the oyster larvæ our observations of the present season have shown that: First, from Parker Run to Edge Cove, the greatest numbers of oyster larvæ occur, in the long run, in those regions where experience has shown a set is most likely to occur. Second, the position of the former oyster reef on the gravelling at the mouth of the Mullica River was due probably to the higher salinity of the water passing over it, and the larger number of oyster larvæ present there.

On the basis of these findings it would seem advisable to conduct exhaustive surveys of our oyster-producing areas, and to shell all bare bottoms in regions where large numbers of oyster larvæ are found habitually during the spawning season.

VII

SPATTING DATA

Examination of figure 4 shows that large oyster larvæ were present in the water at Tuckerton on June 19, 21 and 23. No more were taken until the thirtieth, when large oyster larvæ, ready to set were found in the samples of all the observation stations visited. Judging from the few large spat found on shells taken later during the summer, it is evident that these large larvæ set during the first two or three days of July.

During July, as shown in figure 5, large larvæ were present in the water most of the time. Experimental cultch placed during this time failed to show any set until the twenty-second. A shell at Station 6 received 4 spat at this time, and Station 3 had one. Setting occurred for several days subsequent to this, and was general over the Little Egg Harbor region. This constituted the principal spatting period of the season. Small shells 2 inches across revealed as many as 50 young oysters. A third, and very light set, took place about August 9, as shown by experimental cultch placed at Station 6.

Although large oyster larvæ were present in the water during the rest of the month, no further setting was observed on our experimental shells.

At Barnegat a very heavy set occurred in the Gunning River region early in July. A lesser set took place at about the same time in the waters near the laboratory. A second and heavier set in Barnegat waters occurred toward the end of July, being nearly coincident with that at Tuckerton. A few recently attached spat were found during the early part of August.

A fairly heavy set occurred over the Great Bay and Mullica River regions during the last days of July.

The good catch of oysters this present season came as something of a surprise, following the heavy set of last summer, 1915. It is a rather unusual circumstance in our experience to have two such seasons of voluminous setting following each other consecutively.

One of the most important results of our season's observations came as the result of a mere accident. For a number of years a large aquarium box, 6 x 2½ feet, has been floated at the stern of the floating laboratory. This has been used for different purposes, such as for planting artificial larvæ. During the past season it was used merely to hold oysters used in spawning experiments. At each low tide the bottom rested on a mud bank. The box was put overboard on June 16, and when taken up on August 26 the bottom was found to be covered with young oysters. Plate I, figure 2, shows the float as it appeared with the living oysters upon it. In figure 1 a closer view of the bottom is shown. In Plate II, figure 1, a still closer view is given with a 6-inch rule hung in the center for comparison.

It is evident at a glance that the oysters on this float set during at least two different periods. The largest ones, clustered about the rule, measured about 1½ inches across, while the smaller ones ranged from ⅜ to ⅞ inch in diameter.

From our data of the summer it is evident that the large oysters set about July 1. The smaller ones, much the more numerous, were undoubtedly part of the general set occurring about July 23. It may be seen from Plate II, figure 1, that several of the larger oysters bear smaller ones upon themselves. One of these is shown to the right of the upper part of the rule which bears two of these small spat.

On June 15 of the present season we drew out some piles which had been driven the year before to hold the Cynthia in her place in Huey's Creek. On one of these we found four oysters which measured as follows: 1½ x 1⅝, 1⅜ x 1⅜ 1⅜ x 1⅜, and 1 x 1 inches. These probably set about August 8 of last year during the principal spatting period. Young oysters of the same age, taken from the beds in the creek, were of about the same size.

These oysters, after about 10 months' growth, were no larger than those of this season's setting, which had grown scarcely two months. How are we to explain this very rapid growth of the present season?

A satisfactory answer probably lies in the following facts: First, experience has shown that oysters which set early in the summer grow much more rapidly, proportionately, than those setting later. Second, situated where it was, the bottom of the box was subjected to a very rapid current caused by the partial obstruction of the creek by the houseboat. Third, our observations showed that there was a great abundance of oyster food in the water during the summer. Adult and very young oysters both grew unusually well for the season, though spat taken from the bottom had but little more than half as great a growth as those on the box.

In so far as the increased growth of these oysters was due to a swift current this discovery has an important economic bearing. Coöperation by one of the largest planters at Edge Cove has been promised for next summer in testing floating crates for holding the cultch, and young oysters during the early part of their growth.

A further example of the effect of current upon the growth of oysters is seen in Plate II, figure 2. This shows a 4-inch iron pipe taken from the Crab Island Thorofare this past summer. These oysters were about 11 months old when the picture was taken, and averaged between 3 and 4 inches in length. A part of this length is due of course to excessive crowding, but aside from that these oysters are from half again to twice as large as those of the same age on inshore beds. From this

same thorofare were taken adult oysters 2 years old which were 4 inches across.

Such examples as these open up possibilities in the development of many of the tidal creeks in oyster-producing regions which are now lying idle, or are but little used.

The entire bottom of the box as shown in the photograph, together with the iron pipe, may now be found in the oyster museum in New Jersey Hall. We are indebted to Mr. Frank Fraser, of Tuckerton, for the latter specimen.

In the following table is given the exact measurement in milimeters of 7 of the larger oysters from the bottom of the box, together with small oysters attached to them. The anteroposterior axis is given first.

38 x 38	bore	a	23 x 21
30 x 31	"	"	19 x 19
35 x 38	"	"	10 x 10
32 x 39	"	"	10 x 9
36 x 36			
36 x 36			
31 x 31			

VIII

OBSERVATIONS ON THE FOOD OF THE ADULT OYSTER

To all investigators of the biology of the oyster, few subjects have made a greater appeal than the problem of the oyster's food. While undertaking an investigation of conditions on the oyster beds of southern Alabama, in the summer of 1914, for the United States Bureau of Fisheries, the writer began a study of this question which has been continued during the past two seasons.

In an able paper by Moore,[1] the known facts regarding the oyster's food are set forth, together with an admirable series of experiments by the author. Methods are given by means of which the oyster-producing possibilities of any region may be determined by a quantitative study of the food organisms present in the water. As a large percentage of the oyster's food consists of diatoms and other microscopic plants, it is necessary only to determine the number of these organisms occurring in any given region.

More recently, Grave, C.,[2] has published results showing the

[1] Moore, H. F., Volumetric studies of the food and feeding of oysters, U. S. Bur. Fish. Bul., v. 28, 1908.

[2] Grave, C., Fourth Report of the Shellfish Commission of Maryland, 1912.

maximum number of oysters a certain ground may be expected to support.

From our studies of the last three years we are prepared to make now a preliminary report of some observations regarding the food of the oyster. The facts given below show that the investigators named above, as well as others in the field, have overlooked one very vital factor.

It is a matter of common observation that oysters left undisturbed for some time on the beds, become more or less covered with extraneous growths of different sorts. In Alabama waters we found great masses of red and brown algæ, as well as one or more species of sponges attached to the oyster shell. Similar growths are common on the oyster beds of New Jersey.

In many cases the algæ are long and hair-like, producing what the oystermen call a "whiskered" oyster. All oyster growers interviewed have been unanimous in declaring that such an oyster is fatter, and in better condition, than one with a clean shell from a point close by. In our own experience we have found this to be true in a majority of cases. Is there any reason for it?

Clusters of oysters were lifted with great care from the bottom, and while under water a portion of the "whiskers" was removed to a watch crystal and immediately examined. In every case we found the algæ to be swarming with minute animal and plant life. In one sample taken last summer the filaments of the algæ were interspersed with great yellow masses of diatoms, of which nearly all were of the general *Navicula* and *Pleurosigma*. There were also great numbers of protozoa and green algæ. Estimating from the sample procured, and the size of the oyster shell, the number of diatoms alone on the surface of this shell must have reached several millions.

The oyster when opened showed the stomach full of food organisms, of which nearly 100 per cent were of the same species as those on the outside of the shell. Observations made on oysters from different localities have shown the same conditions prevailing.

It is clear therefore that external growths on the oyster may serve as a protection and breeding place for myriads of organisms which form the chief part of the food of the host. As a result of their own movements and disturbances of the water, many of them are swept into the incurrent stream of water to the oyster's gills, and thence carried to the mouth.

The above is in entire accord with the findings of Allen,[1] in

[1] Allen, W. R., The food and feeding habits of fresh-water mussels, in Biol. Bul., v. 27, p. 127, 1914.

the case of the fresh-water mussel. The oyster, as it were, bears a "private garden" on the surface of its shell. It is evident, as a result of these observations, that analysis of the water alone cannot be a true measure of the food supply in an oyster-producing region. The fact must be borne in mind, however, that not all external growths on oysters are thus beneficial. Some are very injurious, while still others do not afford a suitable habitat for the food organisms. We hope to carry on more extensive studies in this particular field next year.

IX

FINAL SUMMARY OF THE OBSERVATIONS OF THE SEASON

The results of the season may be summarized as follows:

1. In spite of a backward spring oyster larvæ were present in the water in early June, and were ready to set by the end of the month.

2. During the summer 823 specific gravity readings, and the same number of temperature readings of the water were taken. Altogether, 646 water samples were given microscopic examination for oyster larvæ. At Tuckerton a total mileage of over 300 miles was covered in procuring the samples.

3. A good catch of oyster spat occurred over all the region under observation.

4. It has been possible to predict within 48 hours of the time the oyster larvæ begin to set.

5. The distribution of the larvæ in Little Egg Harbor was worked out in some detail. They were found to occur in the greatest numbers near the head of the bay, and to follow the shore line with the ebb and flow of the tide. Comparatively few larvæ of this region reach the sea.

6. Oyster larvæ from Great Bay pass out to sea with the ebb tide, and for the first part of the flood return again.

7. Our studies of the past season have shown the oyster larvæ to occur most numerously in those regions which experience has proved to be the best setting grounds.

8. Oysters attaching to the bottom of a floating box early in July grew to be 1½ inches across in less than two months.

9. The effect of current on the rate of growth was illustrated by oysters 10 months old from the Crab Island Thorofare, Great Bay, which averaged from 3 to 4 inches in length.

10. Examination of external growths on the shell of living

oysters shows that certain ones, chiefly the red and brown algæ, harbor large numbers of food organisms.

From the Zoological Laboratory of the University of Wisconsin, October 27, 1916.

X

EXPLANATION OF CURVES

Figures 1 to 6, inclusive, show the daily fluctuations in the temperature and salinity of the water, and the number of oyster larvæ present. The uppermost curve represents the temperature, the horizontal lines marking the degrees from 60° to 90° F.

The curve below this shows the daily changes in salinity, the horizontal lines mark the percentage of salt present, from 1,000, or fresh water, to 1,020, or 20 parts of salt per 1,000 parts of water.

Below this is given the curve of frequency of the oyster larvæ. Each horizontal line marks off 250 larvæ per 12-quart sample. The points plotted are for the average of each day's samples. In figures 4 to 6, the heavy broken line shown, the curve for total oyster larvæ, represents the number of large larvæ in the water. All larvæ 0.200 mm. in diameter, or over, are included in this class. Such larvæ may be expected to reach the setting stage in from 3 to 5 days. Where the line in these plates rises to an apex it indicates the presence of more than one such larva to each sample.

The days are plotted on the horizontal axis in the tables, a vertical line being drawn at every fourth day.

Figure 1.—Barnegat, June.
Figure 2.—Barnegat, July.
Figure 3—Barnegat, August.
Figure 4.—Tuckerton, June.
Figure 5.—Tuckerton, July.
Figure 6.—Tuckerton, August.

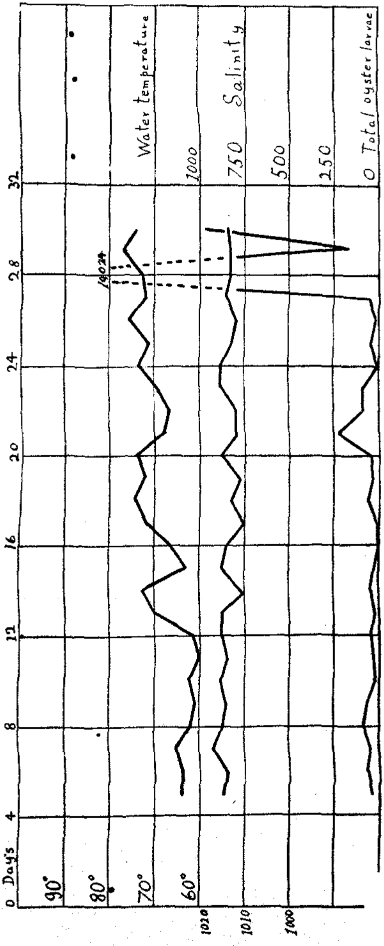

Fig. 1.—Diagram showing records taken at Barnegat, N. J., in June.

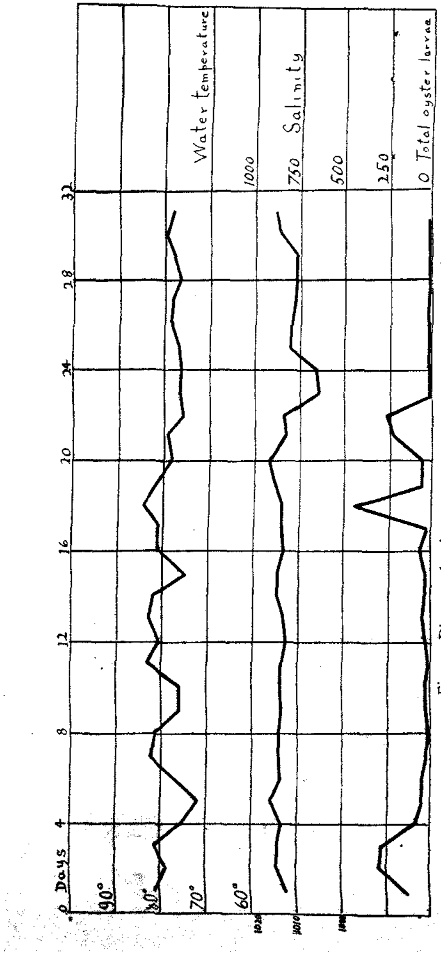

Fig. 2.—Diagram showing records taken at Barnegat, N. J., in July.

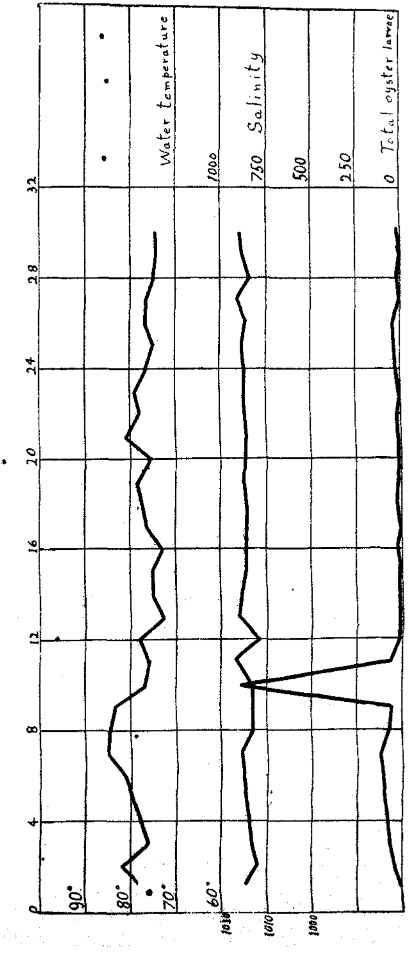

Fig. 3.—Diagram showing records taken at Barnegat, N. J., in August.

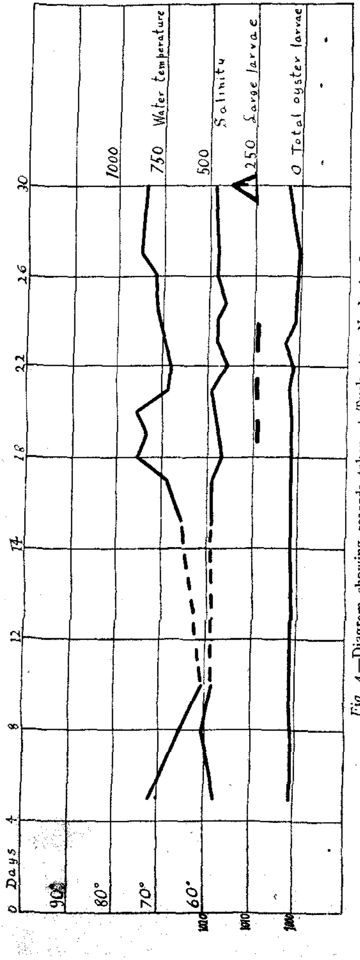

Fig. 4.—Diagram showing records taken at Tuckerton, N. J., in June.

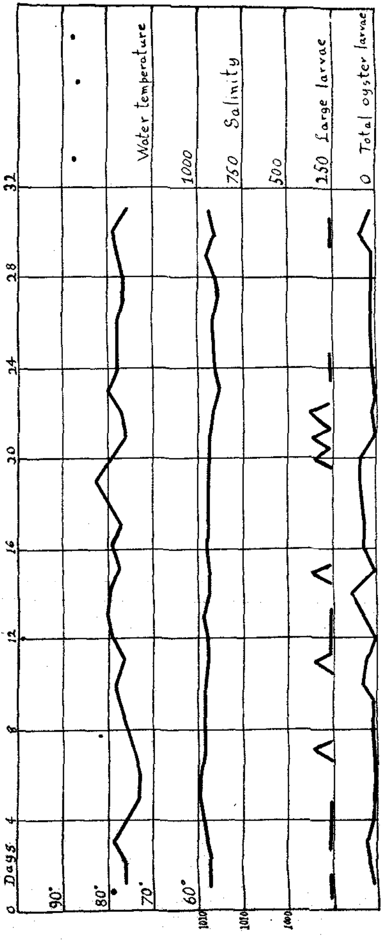

Fig. 5.—Diagram showing records taken at Tuckerton, N. J., in July.

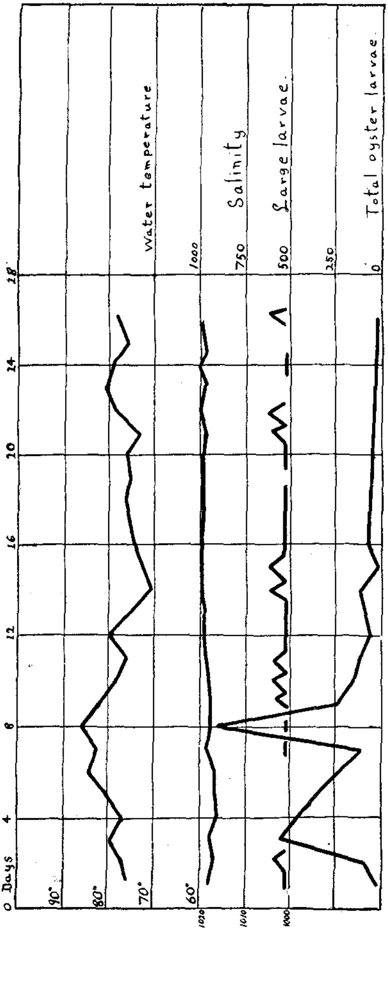

Fig. 6.—Diagram showing records taken at Tuckerton, N. J., in August.

Fig. 1.—A set of young oysters.

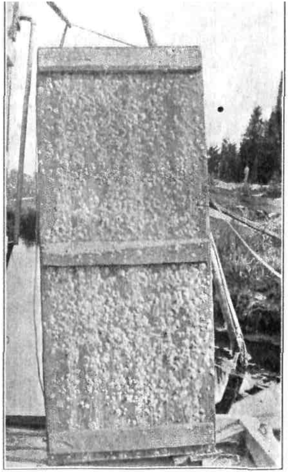

Fig. 2.—Bottom of float showing set of young oysters.

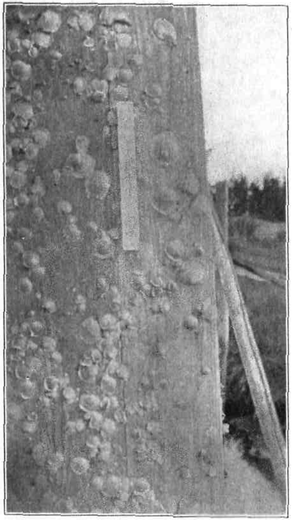

Fig. 1.—A closer view of a portion of the float shown in plate 1, figure 2.

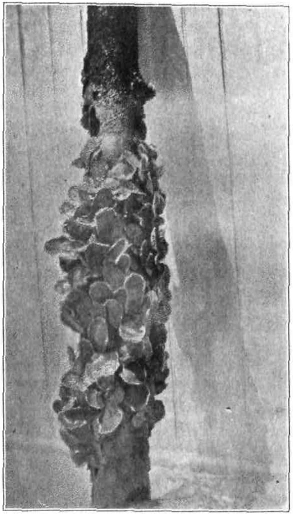

Fig. 2.—Oysters about 11 months old clustered on an iron pipe taken from Crab Island Thorofare.

DEPARTMENT OF BOTANY

Department of Botany

BYRON D. HALSTED, SC.D., *Botanist.*
JOHN W. SHIVE, PH.D., *Plant Physiologist.*
EARL J. OWEN, M.SC., *Assistant in Botany.*
MATHILDE GROTH, *Laboratory Assistant.*
ORVILLE C. SCHULTZ, B.SC., *Research Assistant.*
*WILLIAM S. PORTE, B.SC., *Research Assistant.*
FIDEL P. SCHLATTER, B.SC., *Research Assistant.*
†JOHN V. PIPER, B.SC., *Research Assistant.*

* Resigned April 15, 1916.
† Appointed October 1, 1916.

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Report of the Department of Botany

BYRON D. HALSTED

I

INTRODUCTION

The work of the last year has been along the lines previously reported upon, and is embraced by the following three projects: (1) heredity, (2) environment, and (3) toxicology.

Under "heredity" the main points in mind are the rules that govern the transmission of qualities, with the hope of aiding those more advanced crop-growers, who are inclined to try their hands at plant breeding.

The subjects being studied are chiefly several truck crops, the leading ones of which are corn, beans, tomatoes, peppers, egg-plant and okra. Enough data have been gathered to warrant the opinion that the breeder should be keen to observe differences in the direct offspring of the cross and select accordingly, and not delay until the second generation, before choosing the parents for future strains. Thus it has been shown that corn may vary widely in the first year after the cross, and from such a block plants may be selected for the desired character of stalk, ear, cob, grain, etc., and thereby hasten the time for the fixing of the same.

Studies are in hand with regard to the best combination to make between two breeding subjects. It is not infrequent that one kind does better as the pollinator than as the seed parent, as for example, between the Currant and Ponderosa tomatoes. Among some kinds of peppers it is next to hopeless to get reciprocal crosses in one direction, while in the other the union is easy. This is well illustrated by the Golden Queen and Red Cluster peppers, the former being bred with great difficulty upon the latter, and even then the offspring are practically sterile.

Under "environment" the work is confined chiefly to studies of the influences that are within the plant, while, however, something has been done as to the effect of greenhouse surroundings, as compared with those of the field, upon the size, form and structure of the flower and fruit. As an instance of

the former group the bean, pea and soybean are employed as subjects for the study of the influence of position in the pod upon the weight, form and value for planting of the seed. The results thus far obtained, point to the more centrally located as the best seeds, and it is furthermore observed that here is found the least amount of abortiveness of the ovules.

Under environment outside of the plant, it is being determined with peppers, for example, that those plants that are grown in the greenhouse have fruits that differ materially in size and shape from those from the same lots of seed that mature out of doors.

Under "toxicology" the researches for the present are limited to the consideration of the influences of different strengths of four salts of phosphoric acid, of calcium, potassium, sodium and ammonium, upon seedlings of a strain of Wilson soybeans. As a ground work a study is in progress relating to the effect of different strengths of single salts upon the germination of several of the larger types of seeds as Lima and other beans, peanuts, corn, etc.

It is a pleasure, to record, that the greenhouse laboratory has been built within the year and is serving its purpose in plant physiology (toxicology) admirably.

There has been no material change in the personnel of the staff. One research assistant resigned to fill a teacher's position and another has been appointed to succeed him.

II

EXPERIMENTS WITH CORN

The field work with corn had for its ground plan a study of the relation of position of the grains upon the cob to crop-production. At the same time other problems were in hand, and for this purpose F^1 ears of several crosses were used, two selected from each cross, one ear resembling one parent, and the second the other, they being the extremes in the series of ears that resulted directly from the F^1 grains. The ears, after being weighed, had the grains separated into ten groups of equal number, which in turn were weighed. In the field a row of 10 hills (50 grains) was planted from each group, thus making a block of a hundred hills for each of the ten positions upon the cob from the basal zone to the tip. A similar planting was made for the companion ear and alongside of the other, so that the two blocks would be subjected to similar environmental

conditions, and could be studied in a general way at the same time.

The parents of all the crosses, with a single exception, and usually a quantity of the F^1 grains of each cross were grown.

As an illustration, the cross of New Tom Thumb upon Hopi was represented in the series, therefore an F^1 ear from a hundred or more grown in 1915 was selected that most resembled the New Tom Thumb; that is, it was short, broad, with the fine grains placed zigzag upon the cob. The companion ear for the same F^1 crop was chosen, because long and slender, with its grains in regular rows, as characteristic of the Hopi variety.

Field notes were taken of the growing plants, and it was found that from the time the seedlings appeared there were differences between the companion blocks, and also the rows in a single block were not alike. At a distance the long series of belts of corn showed a wavy outline; that is, there was a rise and fall that quite regularly corresponded to that the grains had upon the cob before they were planted. In other words, there was a rise from the basal zone, and then a long descending line to the top row.

Just as the plants were passing the blooming period, the height of each plant was taken, this being possible, because the field represented kinds that varied greatly in their rapidity of growth, as for example, Black Pop, Golden Bantam, Golden Queen and Iowa Silver-Mine.

The grains were all dropped 5 to the hill, and when the plants were nearly 2 weeks old, the viability of the seed for each zone upon the cob was taken from the whole field.

From the records it is seen that certain portions of the ear have more viable grains than others, and they also show that in certain pairs one ear had much better seed than the other.

As the growth of the crop progressed, it was noted that one combination matured much earlier than another. For example, the block planted from an ear of New Tom Thumb upon Golden Bantam that resembled the latter, ripened several days before the plants that came from an ear of the opposite extreme, that is, conformed most closely to the New Tom Thumb. Furthermore, the earlier block had a considerable percentage of its stalks that were still earlier than the bulk of the crop.

In observations like the above rests the importance of emphasizing the value of a most careful selection of seed from the F^1 plants, in order to segregate with the greatest speed and effectiveness those characters that are desired in the extracted strains of the cross.

The F^1 plants were grown beside the first row (basal) of the F^2 of the same cross. They were usually more uniform than the latter, and sometimes would average several inches taller in spite of the fact that the seed planted was a year older in all cases.

Some kinds that had been bred together differed widely in the tassel. Thus the New Tom Thumb has a very thick central spike, while the Golden Bantam tassel is slender. It was quickly observable that the tassel character exhibited interesting breeding tendencies, and that, while the range was great, the larger number of plants had the thick tassel of the New Tom Thumb.

It is too soon after the harvest to have made a digest of the records, and this is but a general statement of the season's tests.

Plate I* shows some of the results with the ears of the cross of New Tom Thumb upon Hopi. At the left of the upper row are two ears, showing the extremes in the crop of New Tom Thumb. All ears of this variety of popcorn are short and broad, that is, the index (length divided by width—L/W) is low, and the small rice grains are arranged zigzag. The Hopi ears vary much in length and number of rows, but most strikingly in the color, some ears being splashed with dark purple upon all the grains, while others are nearly white, excepting the embryo, which is dark red or purplish.

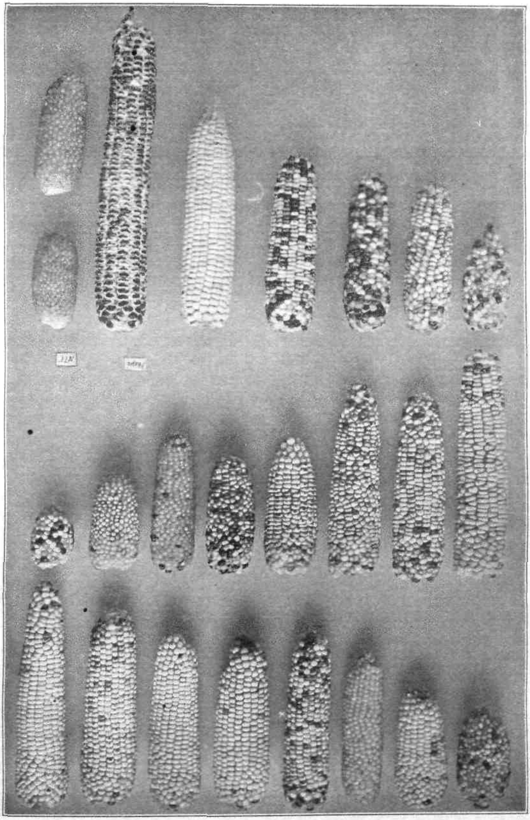
To the right of the parents are four ears selected from the F^1 crop. The extreme types are represented by two intermediates. It is observed that all ears carry the dark color, but its distribution is not uniform upon the grains of any of the ears. In size, the ears are intermediate, excepting the one to the right, and this approaches closely that of the New Tom Thumb in size and arrangement of grains, but not in size of kernels.

The second row of eight ears is made up of ear types, selected from the hundred hills planted from an F^1 ear that most closely resembled the pop-corn. The arrangement is from left to right, beginning with the type most like the pop-corn parent, and closing with an ear that is practically an extracted Hopi, so far as size of ear and grain are concerned.

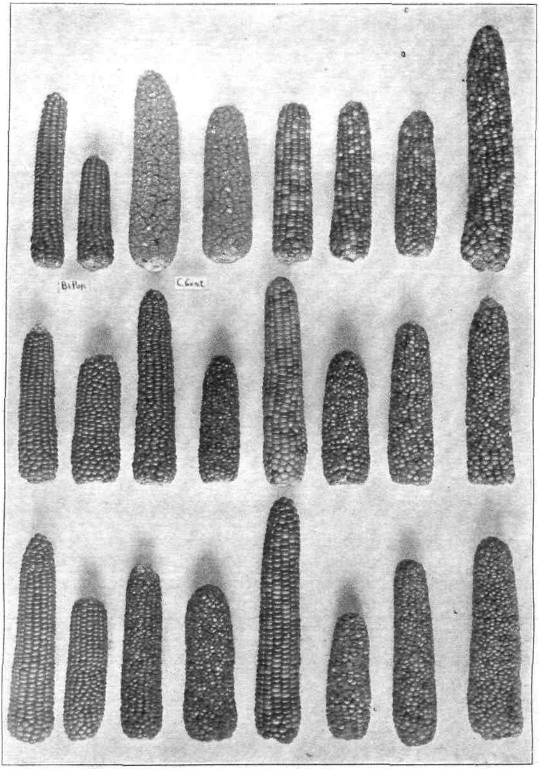
It is noted that the dark color is present to some degree in all the ears, but it is very variable in amount and intensity. The zigzag arrangement of the grains is evident in all, excepting the largest ear to the extreme right.

In the lowest row is a set of typical ears from the hundred hills planted with grains from an F^1 ear that most resembled

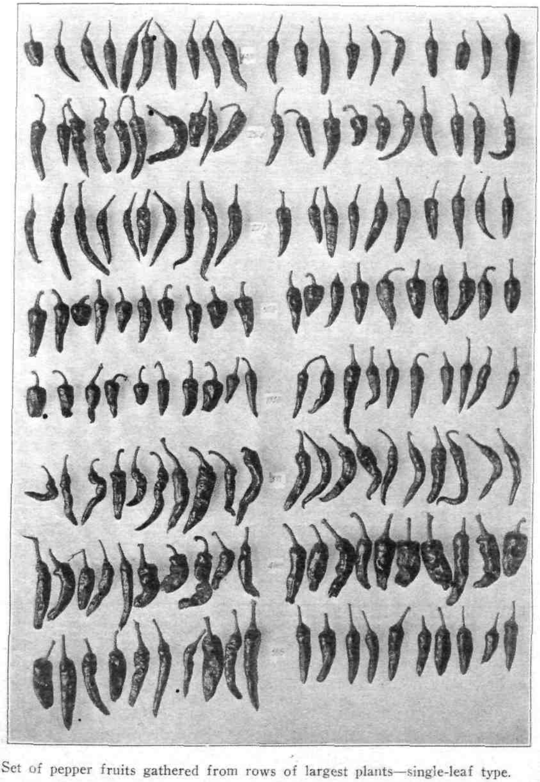
* The photographs for the plates here used were provided in the Department through the kindness of Dr. J. W. Shive.



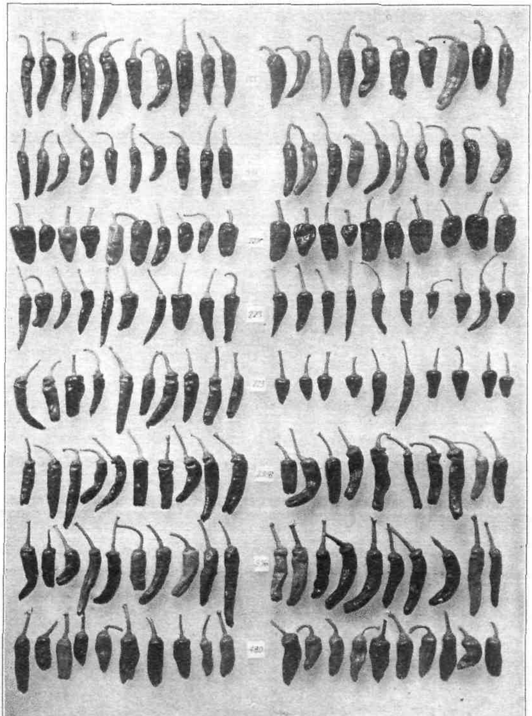
New Tom Thumb upon Hopi.



Black Pop upon Country Gentleman.



Set of pepper fruits gathered from rows of largest plants—single-leaf type.



Set of pepper fruits gathered from rows of largest plants—facicled type.

the Hopi parent. This set is a companion to the one above, and when compared with it, is found to be similar in amount and distribution of color of grains, but the kernels are much more uniformly in regular rows, and, therefore, follow the arrangement of the parental grains. Further differences and agreements may be brought out when the lengths of stalk, ear, etc., are averaged.

Plate II shows a similar display to that of Plate I with the F^1 and F^2 of the Black Pop upon Country Gentleman. The parents are shown in their extreme types in the upper left-hand portion of the engraving. This, it is seen, is a combination of two widely different kinds of corn. To the right of the parental ears are the extreme types of F^1 ears with two intermediate forms between them. It is evident that neither the Pop nor Gentleman is recovered, but the large size of the ear most closely resembling the sugar corn is in accord with the general rule of added size and vigor in the F^1.

In the middle row is shown a set of eight types of ears in the F^2, selected from a hundred hills planted with grains from F^1 ears that most resembled the Black Pop corn. It is seen that the Black Pop type of ear is at the left, while in size and shape the Country Gentleman is well represented at the extreme right of the series, with the intermediates placed between. Solid black and flinty ears are shown of two shapes at the left, and three of the zigzag and mixed type are given at the right.

In the lower row is a companion set of typical ears selected from a block of one hundred hills planted with grains from an F^2 ear that closely resembled the Country Gentleman parent.

It is seen that the two sets show practically the same range of types, the chief difference being in the relative number of ears in each type and some other details as of length of stalk, etc., that must be reported upon after the weights and measurements have been studied.

Inheritance of Partial Sterility in Corn

For two seasons a study of the inheritance of sterility in corn has been in progress. The subject for the past year has been a cross of the Golden Queen pop-corn upon Hickory King in the third generation. A half plot was planted with grains from ears that had the grains separated from each other upon the cob due to the abortiveness of a large percentage of the ovules.

The following is a tabulation of the results:

Number of stalks,	392	
Total ears,	297	
Ears with the grains isolated,	62.	20.9%
Ears with poor setting of grain,	117	39.4%
Ears normal,	118	39.7%

It is noted that only 75.8 per cent of the stalks produced ears. It is further seen that fully 60 per cent of the ears show more or less strikingly the abortiveness of the ovules.

It remains to isolate the strain of corn having the active factor for sterility, and at the same time determine whether the fault lies in the pollen or ovule, or both.

III

EXPERIMENTS WITH PEPPERS

1. The Golden Queen Upon Red Cluster

The above-named cross was carried forward to the fourth generation. Comparatively few plants of the parents and F^1 and F^2 were grown, first, for further study, and second, to get a record of any modifications due to the peculiarities of the present season. The F^3 and F^4 were grown in large numbers in alternate rows of 20 plants each, and these were studied in many details. Records, for example, were made of size and character of plant, leaf and fruit, but it is too soon to draw conclusions from this accumulation of data.

Plate III shows some of the F^3 and F^4 crop, arranged according to the following plan: In each horizotal row the ten fruits upon the left of the record number are from ten plants of the F^3 while those upon the right are likewise average fruits from the plants of the F^4. The plants represented were taken in regular sequence in the row, and, therefore, not selected.

The kinship of the two sets of fruits in a row is of the closest character. If the feminine gender is employed for convenience, the F^3 plants are sisters each of which is aunt to the plants in the F^4 row. In other words, from a selfed fruit in 1914 some plants were grown in 1915, and from a selfed plant of one of these the present F^4 set was obtained, while the companion row grown along side came from the above-mentioned selfed fruit of 1914. The F^3 row was, therefore, grown from seeds a year older than those used for the F^4 set.

It is noted that there is a marked similarity between the F^3 and F^4 sets of fruits for each record number. For instance,

from a glance from the first set (140) to the fourth (315B) and on to the sixth (371) it is evident that among a wide range of shapes and sizes there is a general uniformity in any particular set. It seems quite clear that a large number of fruit-types may be secured by selection.

The Plate III shows only set of fruits gathered from rows averaging the largest plants, and of the non-facicled type. The respective weights of the several group of fruits are shown in tabular form below:

	Weight	
	F^3	F^4
No. of Set	*gm.*	*gm.*
140,	40.5	34.6
257,	56.0	46.0
277,	48.0	44.0
315B,	55.8	62.0
353B,	43.4	44.0
371,	67.8	69.6
406B,	80.8	124.0
556,	86.4	56.8
Totals,	478.7	481.0
Averages,	59.8	60.1

From the above figures it is gathered that the total weight of the eight sets are practically the same for both the F^3 and F^4. It is further seen that the weight of the ten fruits from any row is usually near to that of the companion set. There is perhaps less uniformity in size and shape, and here the F^3 is more diverse as particularly shown in the fourth row where the fruits approximate two types.

A similar study was made of fruits from the sets of smallest plants with foliage of the ordinary type.

	Weight	
	F^3	F^4
No. of Set	*gm.*	*gm.*
140A,	38.0	39.0
289A,	35.5	40.0
289B,	35.5	33.0
333,	44.8	59.5
339,	56.0	51.0
423B$_1$	81.0	82.0
424,	75.0	62.3
484,	66.5	68.3
642,	102.0	93.0
Totals,	534.3	528.1
Averages,	59.4	58.7

The average weights are practically the same for the combined nine sets, and also agree closely with those of the fruits from the largest groups of plants. Here again it is shown that the two generations of any particular set vary in the same direction from the average, and nearly equally.

Plate IV is a companion of the preceding engraving, this one showing corresponding sets of fruits gathered from rows of the largest plants of the facicled type of foliage. The plants with leaves borne in clusters are in general much more compact than those with normal foliage, and earlier in maturing fruit. The reader, by comparing the two plants, may be impressed with the broad tip and shoulder of the fruits from the facicled plants, and a far less inclination to be twisted or even wrinkled than the fruits from non-facicled plants. The correspondence between the F^3 and F^4 is usually so strong that one is inclined to the opinion that in No. 223, where this is strikingly lacking, there may be an experimental error involved.

The fruits are generally larger in this series than in its companion by about 20 per cent, as the following tabulation shows in detail:

No. of Set	Weight F^3 gm.	Weight F^4 gm.
143,	91.6	106.0
153,	46.0	62.0
222C,	74.4	91.5
223 (1),	66.0	53.6
223 (2),	77.0	53.5
238,	83.8	87.3
256,	96.0	118.4
480,	71.0	77.0
Totals,	605.8	649.3
Averages,	75.7	81.2

In general the results are quite parallel to those in the previous displays; that is, the totals are not widely different, and the two generations of a set vary together from the general average, the greatest difference being in No. 223, previously referred to as possibly at fault, and yet this one admits of an explanation under the rules.

The groups of sets selected from the rows of facicled-leaved plants of small size furnishes the following tabulated results:

No. of Set	Weight F^3 gm.	Weight F^4 gm.
110A,	39.4	44.0
110B,	33.0	53.0
110C,	40.3	49.0
205A,	75.3	99.5
327A,	72.4	58.0
327C,	65.5	68.6
393A,	33.0	54.0
393B,	39.6	42.0
Totals,	398.5	468.1
Averages,	49.8	58.5

When compared with the last table it is seen that the fruits average much smaller, and similarly the F^3 is lighter than the F^4 set. As the seedling plants grew in the greenhouse as halves of the same rows, it was evident from the first that the F^4 plants were the stronger, and this difference was maintained throughout the season. It should be kept in mind that the F^3 seeds were a year older than those of F^4, an unavoidable difference in studies of this kind.

II. The Upright Sweet Salad Upon Bond Cross

The above cross is between two contrasting kinds of peppers. The Upright Sweet Salad is a tall variety with the medium-sized fruits sweet and more or less lobed, while the Bond is a low, spreading, fine-leaved, ornamental sort, bearing innumerable small upright, pungent fruits.

This cross has been grown in its F^1 and F^2, and is illustrated in Plate V. Two fruits of the Sweet Salad (No. 31) are given, one showing the pointed tip and the other the deep tri-lobation, frequently met with. At 142 (the record number) are two sprays of Bond, and the contrast in size of fruits of the two parents is most striking. The Bond agrees with No. 31 in color and upright position of fruits, and, therefore, all the offspring are alike in these two characters, but in general the crosses exhibit a wide range of differences in plant, leaf and fruit.

The upper row (31/142 F^1) shows a sample fruit from each of ten plants, and so far as size and shape go, they are uniformly intermediate, but as yet the computations of the records have not been made, and the deviations from the mean in various particulars are not at hand. In the second and third row (31/142) the F^2 is shown by representative fruits from 29 plants, arranged somewhat as to size from those like 31 to those most resembling 142. It is evident that the range is great, while

at the same time with this short series no plant at all closely reproduces the fruit-type of either parent. In the lower two rows are shown single sample fruits of 35 plants of the reciprocal (142/31) also in the F^2. Through the eye one is not impressed with striking difference in the two series, and it is left for the records of weights and measurements to show whether the way the combination is made is significant. As a practical fact, the crossing upon 31 secures a large number of seeds from one operation, while in the opposite direction the small fruit, thus secured, has but few offspring.

III. The Red Cluster Upon Celestial

In the above cross the attempt was to bring together the kinds with their fruits born upright and pointed, but with a striking difference in fruit coloring. Both kinds are red, but while the Red Cluster in maturing passes directly from green to red, the Celestial has an intermediate lemon-yellow stage.

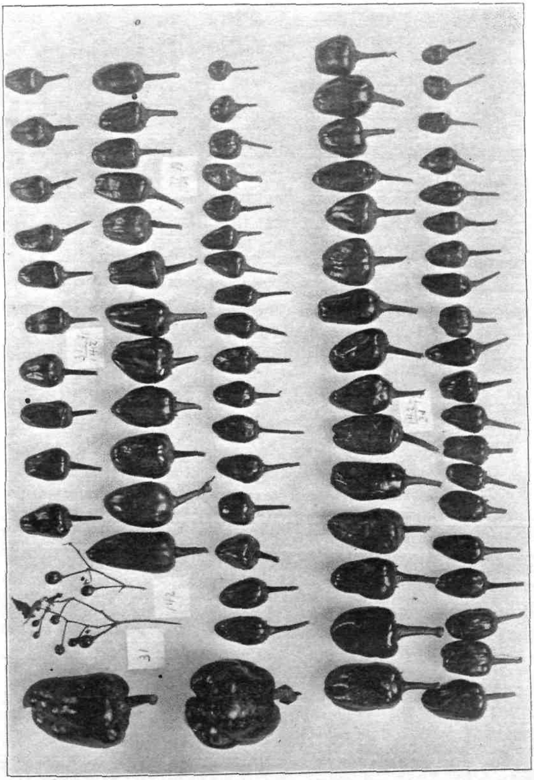
In the F^1 the fruits mature in nearly the ordinary way, that is, they do not show any marked influence of the factor for the lemon-yellow color, but in the F^2 it appears in enough plants to suggest that it may observe the Mendelian rule for a recessive.

Plate VI shows samples of the fruits of the parents at 21 (record number for Red Cluster) and 7 (Celestial), and to their right are single samples of twenty F^1 plants, and the lower two rows contain similar samples from forty F^2 plants arranged somewhat as to their general shape. It is to be noted that in the F^1 the fruits are fairly uniform and intermediate between the parents. In the F^2 the range in size and shape is wide, but in no instance is either parental extreme regained.

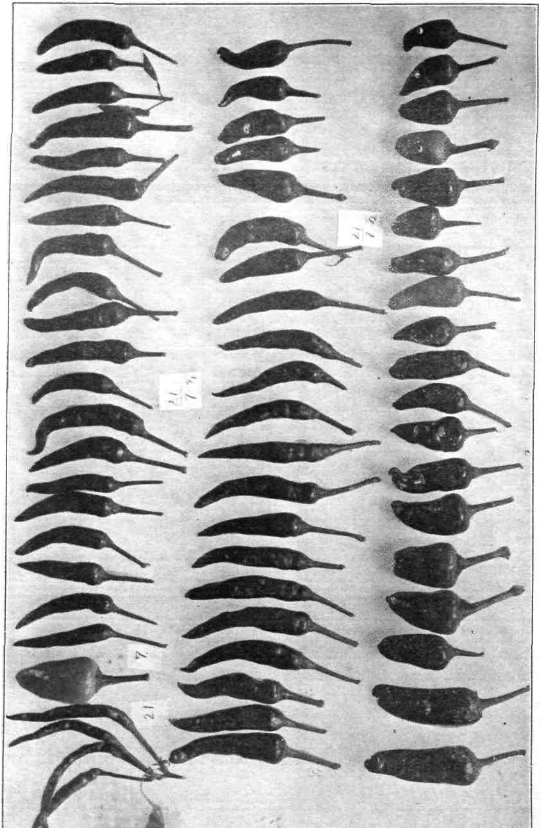
IV. The Wrinkled Upon Long Red Cayenne Cross

The Wrinkled pepper is an ornamental kind that is grown chiefly for the peculiar forms of the fruits. Elongation of the pepper ceases quite early in its development, and the fruit becomes much contorted by the time it is mature. The color is somewhat variable, but usually near a lemon-pink, and the odor and extreme pungency are peculiar. The whole plant, in fact, is different from the ordinary garden pepper, and in breeding with it the results suggest a distinct species.

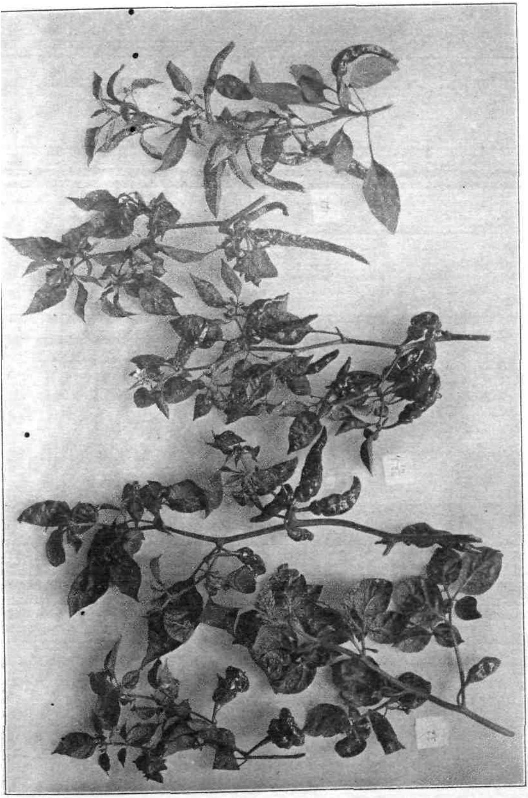
Among other unusual characters the nearly oval leaves are wrinkled, and in this agree with the fruits. It would seem that a factor restricting the elongation of foliage and fruit is common to the plant, but not resulting in a dwarf.



Upright Sweet Salad upon Bond.

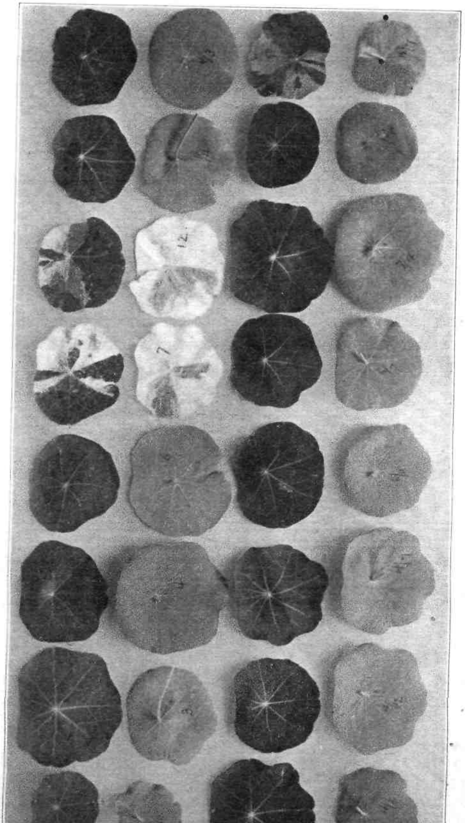


Red Cluster upon Celestial.



Wrinkled upon Long Red Cayenne.

PLATE VIII.



Leaves showing results of crossing nasturtiums.

Plate VII shows sprays of the Wrinkled to the left and of Long Red Cayenne at 41, with the combination ($32/42F^1$) placed between. It is to be observed that the hybrid fruits combine the qualities of the two parents in such a way as to yield long and very much wrinkled peppers, which in this generation are red, like the Cayenne parent.

The special point to be considered here is the nature of the foliage of the hybrids. The leaves are fairly intermediate between the form of the Wrinkled and the elongated type of the Cayenne, and partake quite strongly of the wrinkled character of the pollen parent. It remains to be determined as to the inheritance of the peculiarity of tissue-growth in succeeding generations.

IV

BREEDING OF NASTURTIUMS

A beginning has been made in the breeding of nasturtiums, and the work includes combinations between dwarfs and standards, dark and light-leaved kinds, and sorts with solid green and variegated foliage.

The work has extended only into the first generation, and while the instances are few, it seems evident that the standard kinds are dominant for size over the dwarf sorts, that the factor for dark foliage is dominant over that for light green, and the factor for solid green foliage is also dominant, the variegated type disappearing in the F^1.

The crosses were grown in the field with the parents, and their superior vigor was a matter of comment, both as to size of plant and blossom, the latter being particularly abundant.

During last year, both in the field and greenhouse, many attempts were made to secure selfed seed of the various crosses, but without success. The crosses are being propagated by cuttings, with the thought of cross-pollinating between widely separated stocks from the same mother-plant.

Plate VIII shows typical leaves from the upper and lower side of six of the breeding varieties, followed by corresponding pairs of leaves of several crosses, as indicated by the fractions upon the leaves, placed bottom uppermost. No. 1 is a small light green-leaved dwarf type, and the first of this cross is with a standard dark green-leaved kind. Nos. 3 and 4 bring together a light and dark standard sort, the dark color appearing only in the F^1. At 7 and 12 are shown two of the highly ornamental variegated-leaved commercial kinds, and all of the several crosses shown, namely, 4/7, 4/12, 6/7, 7/4, and 12/4 are with solid

green leaves, the only variegated-leaved cross shown in the plate being between parents having the variegated foliage.

There are many features of the work with the nasturtium that, while even more important than those mentioned, are not ready for any definite statement. Of such, for example, is the behavior of the crosses as regards size, form and venation of the foliage. The ivy-leaved type seems to modify the shape in its crosses, and the purple color in leaf, petiole, etc., has an influence that is not easily measured.

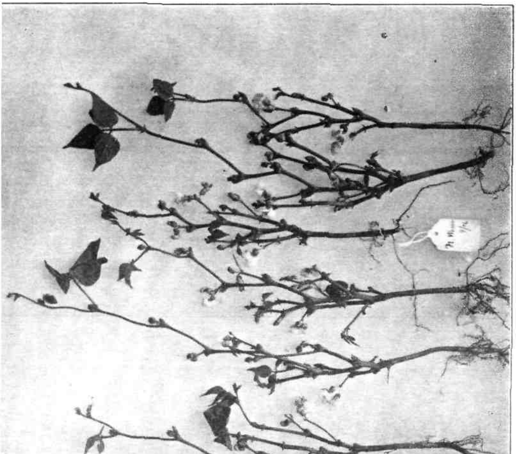
V

ENVIRONMENT OF PODS AND SEEDS IN BEANS

A study of the environment of bean pods and their seeds is prefaced by a knowledge of the sequence of blooms upon the plant. From an inspection of several kinds of bean plants in blossom, the assumption is warranted that a general rule is followed. It is therefore to our purpose to study the anthesis in a representative kind, namely, the Early Wonder, and particularly in plants that have had only medium conditions for development; that is, grown in mid-season upon fairly rich soil.

The seedling bean first brings its pair of thick cotyledons to the surface, and from between them develops the plumule, producing a pair of simple (primary) leaves. Following these, the compound leaves are borne alternately in practically two ranks, so long as leaves are produced, which in beans is dependent more or less upon the conditions of moisture, heat and light that surround the plant.

The flowers, and consequently the pods, are produced upon offshoots of the main stem, and it is upon these branches that attention must now be centered. It seems probable that each cotyledon and leaf bears at least one incipient bud, but many fail to develop, except when unusual circumstances call them forth. As a rule, the first side branch to grow is from the axil of the first trifoliate leaf, and the order of branch formation is quite regularly from this one upward along the main axis, while at the same time opposing branches may arise from the axils of the pair of primary leaves, and later the buds may develop somewhat that are associated with the cotyledons. These reserve buds come forward rapidly when the upper portion of the plant suffers serious injury. The normal Early Wonder plant is made up of two series of branches; first, those that produce leaves and axillary buds and grow on somewhat independently and in a measure repeat the main stem, and, second, those branches that are formed in the upper portion of the central



Sequence of Bloom in Beans.

stem and bear only pods. It is necessary to bear this distinction in mind in determining the sequence of the blooms and age of the pods upon a plant.

The flower buds are generally formed in pairs, but they do not all produce blooms and pods, and the earliest are formed at the lowest node, so far as the later leaf-bearing branches are concerned. However, the lowest flower branch without leaves, and therefore located in the center of the plant body, is usually as early in showing flowers as the basal buds in the lowermost side branch. It is evident from this that the sequence of blooming is more orderly that it seems.

Plate IX may aid the reader in gaining the desired information concerning the sequence of blooms in the bush beans. In the engraving are shown nine New Wonder plants of a mid-season crop, taken at random, when they are entering the blooming phase, and showing the close adherence to the order above described. The foliage has been removed, leaving only the branches with their blossoms and buds. It is to be observed that the first branch of any size is from the axil of the first leaf that is borne alternately. There are usually five of these side branches that carry leaves surmounted by the prolonged stem that bears its series of axillary flower buds usually in pairs.

A close inspection will show that the buds now open are generally the basal pair, in the lowest side branch, and the first pair of buds produced without a leafy branch; that is, just above the last side shoot. Occasionally a third pair of blooms is in sight, and is at the node of the second branch.

A practicable method of securing the pods from the plants in their order of formation is by a series of pickings from marked individuals. By this means the first six pods, for example, will be the three pairs above named as the earliest buds to blossom. The next six pods will include those produced upon three or more branches, and therefore scattered throughout the center of the plant. The latest pods may be still more separated, and embrace those that are uppermost upon the side branches and the central stem and any that may have developed in the axils of the pair of primary leaves, or even from the buds associated with the cotyledons.

There are many other minor details in the branching and the floral development in beans as, for example, there is a latent bud at the base of each side branch, and this may develop a flower and a pod late in the season when circumstances favor great activities in the plant.

VI

EXPERIMENT WITH PEANUTS

Relation of Position in the Pod to Productiveness

Two kinds of peanuts are used in these tests, namely, the Tennessee and the Virginia. These varieties along with others, as the Mammoth Bush and Spanish, were grown last year, and from that season's crop the seeds were taken for the trials herein reported.

The pods were assorted into four groups, namely, 1-seeded, 2-, 3- and 4-seeded. The 2-seeded were shelled into two groups, (1) the basal, and (2) the tip seeds. In a similar manner the 3-seeded pods made three groups, and the 4-seeded were shelled into four lots, depending upon the position in the pod, making in all ten sets of seeds for each variety. A plot row was planted to each set, there being 10 hills, and 5 seeds to the hill.

The two varieties were in every way treated as duplicate, were grown side by side, and are brought together in the following table, showing total weight of pods:

Position of Seeds Planted	*Weight of Pods gm.*	*Rank for Seeds*	*Rank for Pods*
1—Seeded,	3,337	1	1
2—Seeded base,	2,244	2	3
2—Seeded tip,	2,141	4	
3—Seeded base,	1,985	6	
3—Seeded middle,	2,169	3	6
3—Seeded tip,	1,577	9	
4—Seeded base,	1,509	10	
4—Seeded 1st middle,	1,824	7	7.5
4—Seeded 2d middle,	1,755	8	
4—Seeded tip,	2,016	5	

It is seen that the larger yields, with one exception, are in the upper half of the table, that is, from seeds planted from the pods with the smallest number of seeds. The seeds from 1-seeded pods lead by a large margin, followed by the 2-seeded base. From the column of "ranks for pods" it is shown that the yields fall regularly from the 1-seeded to the 4-seeded pods.

It remains to determine the percentage of the 4 types of pods in the 10 groups, or, in other words, whether there is any inheritance in type.

VII

A STUDY OF THE INFLUENCE OF ENVIRONMENT

Golden Queen Upon Red Cluster F^3 Peppers in (1) Greenhouse and (2) Field

After setting the desired number of pepper plants in the field, the surplus was left to grow in the greenhouse bed. There was no selection made at the time of the field setting, the plants being taken from one end of the row, and the other remaining. Upon the same dates the (1) length and (2) width, and (3) the number of the locules of the fruit were taken, twenty, when possible, for each set from the greenhouse and field plants.

The Table I shows the average for the sixteen sets of plants.

Table I—Averages

Influence of Environment on Peppers

	GREENHOUSE GROWN				FIELD GROWN			
Plant No.	No. of Fruits	Length mm.	Width mm.	Locules	No. of Fruits	Length mm.	Width mm.	Locules
88, ...	18	74.5	13.1	2.9	20	91.0	14.40	2.5
243, ...	8	101.7	17.0	2.5	20	132.9	15.90	2.8
250 A.	13	40.4	20.5	2.2	20	65.7	29.10	2.5
255, ...	17	49.0	12.3	2.2	21	74.0	13.52	2.1
267, ...	15	87.5	9.8	2.2	20	105.9	10.00	2.5
298, ...	14	56.5	15.0	2.6	20	77.5	18.50	2.5
311, ...	12	41.5	15.5	2.0	21	56.9	17.30	2.0
333, ...	16	62.3	9.7	2.0	20	87.7	11.20	2.2
355, ...	9	70.1	11.6	2.0	20	95.4	13.60	2.4
393 B.	17	46.6	12.5	2.0	19	45.1	13.10	2.4
395 B, ...	17	55.6	16.2	2.1	20	73.3	17.80	2.2
402 A, ...	20	64.8	8.8	2.0	21	85.7	10.09	2.0
403, ...	21	41.8	15.3	2.0	21	43.6	17.40	2.0
458.	13	69.0	14.0	2.2	20	98.3	13.05	2.8
475, ...	15	48.5	19.9	2.0	20	71.4	23.40	2.5
482, ...	16	29.3	14.1	2.0	21	44.4	17.00	2.0
Averages,..	15.1	58.7	14.0	2.18	20.2	78.0	15.90	2.27

In Table I the plant number, for example 88, is that of the mother plant, as grown the previous year, from which its selfed seed produced a row in the greenhouse bed, before mentioned. The average length, width and number of locules are given in the left half of the table, and the field-grown fruits are similarly recorded upon the right hand.

It is, of course, true that the subjects were a cross (F^3) between two dissimilar varieties of pepper, particularly in the size and form of the fruit, and the results may not be as satisfactory as when a well-bred, and therefore uniform, strain of some commercial kind is similarly tested. However, the plants

showed so much uniformity, and the number of fruits are so many, that certain facts may be observed. For example, it is noted, with one trivial exception, that the shorter fruits were produced in the greenhouse, and, with two slight exceptions, the narrower fruits were grown under glass. These and other facts are shown below.

Length of Fruits (mm.):	*Range.*	*No. of Fruits.*	*Average.*	*Variability.*
Greenhouse-grown, ...	101.7 to 293.0	241	58.70	24.65%
Field-grown, ...	43.6 to 132.9	324	78.00	24.44%
Widths of Fruits (mm.):				
Greenhouse-grown, ...	8.8 to 20.5	...	14.00	18.70%
Field-grown, ...	10.0 to 29.1	...	15.90	24.05%

It is found that the field-grown fruits average more than a third (36.6 per cent) longer than those of the greenhouse, and in width are 14.6 per cent greater. The last column shows a very marked similarity in the large variability in the fruit-lengths. In the width there is much less range of variability in the fruits produced under glass.

In general this test shows that much smaller and somewhat less variable fruits were produced in the greenhouse. The difference, if any, in degree of pungency was not made a matter of record. Another set of records made with the same cross, including the size of the plant and leaf, involve fifty sets of five plants each, that is, 250 plants. For all the records five typical samples were taken from each plant, thus bringing the actual measurements for the leaf up to 1250, or a total of 6250 for the foliage and fruit.

	GREENHOUSE GROWN			FIELD GROWN		
	Range mm.	Average mm.	Variability %	Range mm.	Average mm.	Variability %
Plant lengths, ...	245–845	525.0	25.85	168–604	401.0	24.37
Leaf lengths, ...	60–156	96.0	17.86	82–176	120.50	16.68
Leaf width, ...	17–37	26.24	13.39	23–47	32.0	13.48
Petiole, ...	20–68	33.3	28.93	31–87	48.5	25.36
Fruit lengths, ...	30–107	38.0	18.39	37–113	67.54	21.37
Fruit width, ...	11–26	17.0	19.41	10–29	16.9	19.76

By averaging all the records upon the fruits the following results are obtained:

Fruit Lengths.	*Average mm.*	*Variability. Per Cent.*
Greenhouse-grown, ...	57.52	21.52
Field-grown, ...	72.80	22.91
Fruit Widths.		
Greenhouse-grown, ...	15.43	19.06
Field-grown, ...	16.40	21.91

It is seen that the larger numbers are always associated with the field-grown fruits; they are longer by 26.74 per cent, while only 6.28 per cent greater in width. The variability in length is somewhat greater (1.39 per cent) in the field set of fruits, and about twice as much (2.85 per cent) in their width.

A comparison between size of plant, leaf and fruit is given below.

	Greenhouse-Grown. *mm.*	*Field-Grown.* *mm.*
Plant lengths,	256.0	401.0
Leaf lengths,	96.0	120.5
Leaf width,	26.2	32.0
Petiole length,	33.3	48.5
Fruit lengths,	58.0	67.4
Fruit width,	17.0	16.9

It is seen that the much taller plants of the greenhouse set have the smaller leaves and fruits. In other words, the condition that favors a large development in the stems was not accompanied by a corresponding elongation of leaf and fruit, but instead the opposite result was obtained.

When the environment is the same, it has been shown in previous years with peppers that large plants average larger fruits than smaller plants of a given kind. But here it appears that conditions that favor length in stems may not develop the fruits in the same direction.

VIII

REPORT OF PROGRESS BY THE PLANT PHYSIOLOGIST

JOHN W. SHIVE

A Study of the Toxic Influence of the Phosphate Salts on Soybean Seedlings

Studies on the toxic influence of the water-soluble phosphate salts on soybean seedlings were conducted throughout the year. The salts employed consisted of mono-sodium, -potassium, -calcium, -ammonium, and -magnesium phosphates. The work with these phosphate salts involved three distinct series of experiments, the purpose of which was primarily to study the toxic symptoms produced in soybeans seedlings by the action of the various salts (1) when used singly in varying concentrations in soil cultures; (2) when used in combination with a complete fertilizer in soil cultures; (3) when employed in water cultures in connection with full nutrient solutions. An outline of the methods employed with a brief statement of the outstanding results only can be given here. A detailed account of these experiments will appear in a later pnblication.

The soil to which the salts were added consisted of a mixture of equal parts by volume of a sandy clay loam and white seashore sand. This mixture provided an unproductive medium, so that the effects upon the growth of the seedling, of the salts added to the soil, were not obscured by the beneficial effects of the nutrient materials already in the soil.

In all the work with soil cultures, the salts were introduced into the soil in the form of solutions. Each culture was prepared by adding 500 c.c. of solution to 4 kg. of air-dry soil. The moisture content of each culture was, therefore, approximately 12.5 per cent of the weight of the air-dry soil, and approximately 33 per cent of the water-holding capacity of the soil. The containers consisted of glazed earthenware pots with a capacity of about 4 liters. The seedlings used in the soil cultures were germinated in moist sand, and were transplanted into the pots when about 4 cm. tall, after which the pots were sealed with paraffine wax.

Since the physical property of a soil solution or of a culture solution which is most apt to influence plant growth is its osmotic concentration, by virtue of which it resists the entrance of water into the plant roots, the concentrations of all the solutions added to the soil, as well as those employed in water cultures, were measured in terms of possible osmotic pressure.

For the purpose of watering the plants, a paraffined paper funnel in the inverted position was placed in the center of each pot. The funnel was partially buried in the soil, extending about one-half the distance to the bottom of the pot, with its upper end projecting above the wax seal. The pots were weighed every third day during the early stages of growth and more frequently during the later stages. At each weighing the original moisture content of the soil was restored by the addition of distilled water. These experiments with the phosphate salts were repeated, so that for all measurements made averages were obtained.

I. *Experiments with phosphate salts used singly in soil cultures.* In the first series of experiments the salts were used singly in soil cultures. Five series of cultures, corresponding to the five different phosphate salts employed, were conducted. Each series consisted of ten cultures. The pure solutions added to the soil of these cultures varied in concentration from 0.5 atmospheres to 7.0 atmospheres of possible osmotic pressure. To eight cultures of each series, beginning with the first culture, were added solutions which varied in concentration from 0.5 to 4.0 atmospheres by increments of 0.5 atmosphere. To the two remaining cultures of each series were added solutions having concentrations of 5.0 and 7.0 atmospheres, respectively. The solutions of each series, before being added to the soil, possessed, therefore, a range in concentration from 0.5 to 7.0 atmospheres of possible osmotic pressure. Each series included also a control culture to which no salt was added.

Specific symptoms of poisoning manifested themselves in the plants of all the cultures to which the phosphate salts had been added singly, except in that culture of each series to which was added the solution having the lowest osmotic concentration (0.5 atmospheres of possible osmotic pressure). The nature of these toxic symptoms was the same in the plants of each series, indicating that the basic elements of these salts are not the main factors causing injury to the plants.

The severity of the injury varied with the plants of different series. The least amount of injury occurred in the plants from the mono-potassium phosphate cultures, while the plants from the mono-calcium phosphate cultures showed the most severe injury, using as a criterion the actual number of leaves from each culture which had been injured, the number of fallen and dead leaves, and the general appearance of the plants. A comparison of the dry-weight yields of tops brings out the fact that the highest average yield from a single culture of the five series was only 94 per cent of the average yield from the control cultures, and was produced by the culture having the smallest quantity of mono-potassium phosphate. If the average yield from the control cultures is considered as 1.00, the highest and lowest average yields from the cultures of the five series are as follows:

	KH_2PO_4	$Mg(H_2PO_4)_2$	NaH_2PO_4	$Ca(H_2PO_4)_2$	$NH_4(H_2PO_4)$
Control, ...	1.00	1.00	1.00	1.00	1.00
Highest yields, ...	0.94	0.84	0.83	0.81	0.79
Lowest yields, ...	0.39	0.24	0.19	0.16	0.15

The above comparison shows that the lowest average yield of tops occurred with the mono-ammonium phosphate cultures. The lowest average yields are, therefore, not coincident with the severest injury to the tops.

II. *Experiments with phosphate salts used in soil cultures in combination with a complete fertilizer.* In the second series of experiments the phosphate salts were employed in combination with a complete fertilizer in soil cultures. As in the preceding experiments, five series of cultures, corresponding to the five different phosphate salts, were conducted simultaneously. In addition to one of the five soluble phosphate salts, each culture contained also the three salts, mono-potassium phosphate, calcium nitrate, and magnesium sulphate. The salts were added to the soil, of course, in the form of solutions. The three salts, mono-potassium phosphate, calcium nitrate, and magnesium sulphate, containing all the so-called essential constituents (excepting iron) of a complete nutrient mixture, were present in corresponding solutions (to be added to the soil cultures) of the five series in the same volume-molecular and osmotic proportions. The different solutions of the same series, before being added to the soil, all had approximately the same total osmotic concentration (2.50 atmospheres of possible osmotic pressure), but each solution of the series differed from all the others in the relative proportions of the four component salts. The relative proportions of the four salts were varied in such a way that a decrease in the partial concentration of one salt was balanced by a sufficient increase in the partial concentrations of the remaining salts to maintain the total osmotic concentration of the solution constant. Variations in the proportions of the four salts used, by increments of one-tenth of the total osmotic concentration, produce a series of 84 cultures. Of these, 20 representative cultures were chosen for each series.

As a means of comparison, a sixth series was also conducted, the cultures of which contained the three salts, mono-potassium phosphate, calcium nitrate, and magnesium sulphate only. For the sake of convenience this series of culnres will be termed the control series, and these cultures must be distinguished from the soil cultures to which no salts were added, and which will be designated the soil checks. The three salts of the control series were

present in each solution (before being added to the soil) in the same relative proportions as were the same three salts in corresponding solutions of the other five series, but the total osmotic concentration of the solutions of the control series was made equal to that of the solutions of each of the other five series (approximately 2.50 atmospheres). Thus, the solutions of the control series before being added to the soil were similar to the corresponding solutions of the other series in the proportions of the three salts and also in total concentration, while the partial salt concentrations of the solutions of the control series were of necessity slightly higher than those of the corresponding solutions of the other series.

It is, of course, not to be assumed that either concentration or salt proportions of the solutions remain unchanged on being added to the soil, since chemical changes undoubtedly take place between the salts of the solutions and materials in the soil, thus changing salt proportions and concentrations. It is reasonable to suppose, however, that any marked difference in the growth of the plants in a control culture and that of the plants in a corresponding culture of another series may be attributed to the effect of the additional phosphate salt present in the latter culture.

Symptoms of the toxic influence of the salts appeared in the plants from those cultures of each series, except the control series, in which the relative proportions of the phosphate salts were high and the proportions of the other salts correspondingly low. No injury occurred to the plants of the control series.

The injury produced in the plants of these cultures was identical with that which appeared in the plants from the cultures in which the phosphate salts were employed singly. Severe injury occurred only in the plants of those cultures of each series having the highest proportions of the phosphate salts and with the lowest proportions of the other salts. The plants of comparatively few cultures in each series were injured, the severest injury occurring in the series of cultures containing the additional calcium phosphate, and the least amount of injury appeared in the series of cultures containing the additional mono-potassium phosphate.

In considering the dry-weight yield of tops, the average weights from the check cultures, to which no salts had been added, are taken as 1.00, and the other weights are expressed in terms of these. The highest and lowest average yields from the cultures of the five series, as well as those for the control series, are given in the following table:

	NaH_2PO_4	$NH_4(H_2PO_4)$	KH_2PO_4	$Ca(H_2PO_4)_2$	$Mg(H_2PO_4)_2$	*Control*
Soil check, ...	1.00	1.00	1.00	1.00	1.00	1.00
Highest yield, ..	1.52	1.48	1.58	1.58	1.36	1.58
Lowest yield, ...	1.03	1.01	0.84	0.65	0.76	0.97

From the above comparison it will be observed that the highest dry-weight yields from the various series range from 58 per cent to 36 per cent higher than the average yields from the soil checks, the highest yields from three of the series having the same value, each being 58 per cent higher than the average yield from the check cultures. The lowest yields range from 3 per cent above to 35 per cent below that of the average yield from the check cultures. It is interesting to note that the highest average dry-weight

yields occurred in corresponding cultures of the six series. These cultures were characterized by having low relative proportions of the phosphate salts, low relative proportions of calcium nitrate, and high relative proportions of magnesium sulphate.

III. *Experiments with phosphate salts used in water cultures in combination with a full nutrient solution.* The third series of experiments were conducted with water cultures. Six series of solution cultures, corresponding to the six series of soil cultures in the preceding experiments, were employed. The solutions of each series were identical with the solutions added to the soil cultures of the corresponding series in the preceding experiments with the phosphate salts. In addition to the cultures of the six series, duplicate cultures with Knop's solution and with Tottingham's best solution for wheat, all with the same total osmotic concentration (2.50 atmospheres of possible osmotic pressure) were conducted at the same time; 250 c.c. of solution were used for each culture.

The seedlings employed in this series of experiments were germinated in moist sphagnum and three seedlings were transferred to each solution when the seedlings were about 4 cm. tall. The solutions were renewed every third or fourth day, and the cultures were continued until the plants had reached the blossoming stage.

Severe injury occurred to the plants in those cultures of each series having high proportions of the phosphate salts. Slight injury occurred also in the plants from the cultures containing medium proportions of the phosphate salts. In the cultures having the highest proportions of these salts the plants were killed before the end of the growth period. In no series did injury occur to the plants of the cultures containing the lowest proportions of the phosphate salts, except in the series containing mono-calcium phosphate. In this series the plants were killed without making any growth, in all the cultures except in those containing the lowest proportions of the mono-calcium phosphate. This series was discontinued.

The nature of the injury sustained by the plants in these solution cultures was no different from that occurring in the plants from the soil cultures in the preceding experiments. The number of cultures affected in each series, however, was greater and the injury was more severe.

In the series of solution cultures (control series) containing the three salts, mono-potassium phosphate, calcium nitrate, and magnesium sulphate, without the additional phosphate salt, injury occurred to the plants from those cultures having the highest proportions of mono-potassium phosphate and the lowest proportions of the other two salts. The injury sustained by the plants of this series was less severe and the plants of fewer cultures were affected than in any of the other series.

In all cases where the tops of the plants sustained injury, the roots also were injured.

The highest and lowest dry-weight yields of tops are presented in the following table. The average yields from Knop's solution are considered as 1.00 and all the other weights are relative to this:

	NoH_2PO_4	$NH_4(H_2PO_4)$	KH_2PO_4	$Mg(H_2PO_4)_2$	Control Three Salts
Yield from Knop's solution,	1.00	1.00	1.00	1.00	1.00
Highest yield,	146	1.43	1.13	0.65	1.52
Lowest yield,	0.34	0.37	0.38	0.31	0.37

Excellent growth was made in the cultures having the lowest relative proportions of the phosphate salts with medium relative proportions of calcium nitrate and magnesium sulphate, except in the series containing the monobasic magnesium phosphate.

The highest average dry-weight yields were produced in a culture of the control series having the lowest relative proportions of mono-postassium phosphate with medium relative proportions of calcium nitrate and magnesium sulphate. The yield from this culture was 52 per cent higher than the average yield from Knop's solution having the same total osmatic concentration. The highest average dry-weight yields from the various series ranged from 52 per cent above to 35 per cent below the average yield for Knop's solution.

Experiments similar to the above, in which the chlorides of sodium, potassium, calcium, ammonium, and magnesium are employed, are now in progress.

Effect of Shading on the Fruit of Pepper Plants

During the growing season of this year experiments were conducted in the field which were designed to test the effect of different degrees of light intensity on the size, shape, and other qualities of the fruits of pepper plants. The plants to be tested were grown in the greenhouse until they were about 10 cm. tall, and were then transplanted to the open field on the experiment grounds of the Station.

The plants were grown to maturity under enclosed shelters 85 cm. square and about 85 cm. high, the walls and tops of which were constructed of parallel-placed wooden strips 3 cm. square, nailed upon frames made of the same material. Four duplicate sets of these shelters were employed. The shelters were so constructed that the open spaces intervening between the parallel strips of the various shelters, beginning with the first, permitted approximately two-tenths, four-tenths, six-tenths, and eight-tenths, respectively, of the total sunlight to pass. The open field, together with the four shelters, thus provided five different exposures. To avoid shading each other, the shelters were placed three meters apart. Two plants were grown under each shelter, and in addition to these, a number of check plants were grown at regular intervals around and between the shelters.

At the end of the growing season the shelters were removed to the greenhouse, where the experiments are now being conducted. The four shelters occupy corresponding positions on four benches at one end of the greenhouse room. Potted pepper plants are employed. The containers consist of glazed earthenware pots having a capacity of about 4 liters. Each pot contains about 4 kg. of rich garden soil in which one plant is rooted. The soil moisture content of all the cultures is approximately the same. The pots are sealed at the surface of the soil by means of paraffine wax, and water is supplied to the roots of the plant of each culture through a paraffine paper

funnel partially buried in the soil in the inverted position, with its upper end extending through the wax seal at the soil surface. The upper opening of each funnel is kept tightly closed by means of a paraffined cork stopper, except for a short period at the time of watering.

Four cultures were placed under each shelter when the plants were about 10 cm. all. In addition to these, four check cultures are also being conducted, making a total of 20 cultures in the entire series. The cultures are watered and weighed every second or third day, and a record is kept of the water lost by transpiration from each plant. This record gives also the data by means of which the water requirements of each plant may be calculated. A record of the highest and lowest temperature reached in the greenhouse room each day is obained by means of maximum-minimum thermometers. The evaporating power of the air in the greenhouse room and also in each shelter is measured by means of standardized porous clay atmometers of the spherical type. A daily record of the water loss by evaporation from each of these instruments is kept.

The data derived from these experiments are at the present time too incomplete to warrant the drawing of any conclusions.

The Effect of Salt Concentration on the Germination of Seeds

The germination of seeds is dependent on the absorption of water when other conditions essential to growth are favorable. A soil solution offers resistance to the entrance of water into plant roots in contact with it, by virtue of its physical property known as concentration, and for the same reason it should offer resistance to the entrance of water into seeds in contact with it. Experiments are being conducted which are designed to determine to what extent the concentration of pure and mixed solutions resist water absorption by seeds placed in contact with them, and whether such resistance to water absorption has a direct bearing upon germination.

The salts thus far employed in these experiments are the nitrate, carbonate, phosphate (mono-basic), and chloride of potassium, magnesium sulphate, and calcium nitrate. The salts were first used singly in sand cultures. They were added to the sand in the form of solutions of varying concentrations, which were measured in terms of possible osmotic pressure in atmospheres. The concentrations of the solutions of each salt varied from 1.0 atmospheres os possible osmotic pressure to 8.0 atmosphere by increments of 1.0 atmospheres. The lowest concentration employed, however, was 0.5 atmospheres, so that the range in concentrations was 8.5 atmospheres. Each salt yielded, therefore, a series of nine cultures, to which was added a check culture containing no salt, making a total of ten cultures in each series.

The seeds thus far employed in these experiments consisted of beans of the variety known as Mohawk, and corn. One hundred seeds were selected for each series of cultures. These were divided into ten groups of ten seeds each, corresponding to the number of cultures in each series employed, and each group of a series was carefully weighed just preceding the time of planting. All weighings were made to the tenth of a milligram.

Each culture of a series was prepared by thoroughly mixing 100 c.c. of solution with 1 kg. of air-dry, white, seashore sand and placing the mixture

thus prepared into containers consisting of glazed earthenware pots, each with a capacity of approximately one liter. Ten seeds which had been previously selected and weighed were planted in each pot as the preparation of the culture was completed. Immediately after planting the seeds the pots were sealed by pouring melted wax over the surface of the sand to prevent evaporation.

The cultures were allowed to stand on a laboratory table at room temperature for a period of from 48 to 72 hours until the seeds had germinated and the primary roots had developed to a length of from 3 to 5 cm. The wax seal was then broken, the seeds carefully removed from the culture, one by one, and the root lengths measured. All grains of sand adhering to the seeds and roots were removed by means of a camel's hair brush. This operation was performed as quickly as possible in order to prevent excessive evaporation. The ten seeds from each culture, together with their roots, were placed in weighing bottles immediately after having been cleaned of adhering sand grains, and the bottle tightly closed. Each bottle with its ten imbibed seeds was then weighed and the weights of the seeds from each culture, the total water absorbed by each group of ten seeds, and the water absorbed per gram of dry seed (original weight) were obtained.

The results of the experiments thus far carried out are briefly summarized in Table II, which presents the average amount of water absorbed per gram of air-dry seed during an average time period of 52 hours and 60 hours for beans and for corn, respectively, for the highest and lowest concentration of each salt employed, in terms of the average quantity of water absorbed by the seeds from the control cultures taken as 1.00. The table also gives the average percentage of germination for the cultures having the highest and lowest salt concentrations, and for the control cultures.

Table II

Data Obtained in Experiment on Effect of Salt Concentration on the Germination of Seeds

	Concentration of Solutions Added to Sand Cultures (Atmospheres)	Relative Quantity of Water Absorbed Per Gram of Dry Seed						Average Percentage of Germination
		$MgSO_4$	KNO_3	$Ca(NO_3)_2$	KCl	KH_2PO_4	K_2CO_3	
Beans, ...	0.0 (Control)	1.00	1.00	1.00	1.00	1.00	1.00	96.9
	0.5	1.11	1.00	1.06	1.12	0.98	9.98	95.0
	8.0	0.80	0.78	0.78	0.83	0.84	0.84	95.0
Corn, ...	0.0 (Control)	1.00	1.00	1.00	1.00	1.00	1.00	97.5
	0.5	0.88	1.02	0.93	1.13	1.06	0.88	96.6
	8.0	0.53	0.64	0.52	0.70	0.69	0.60	97.5

This brief summary shows that the average percentage of germination for the highest and for the lowest salt concentrations here employed is practically equal, and this is only very slightly lower than the average percentage of germination for the control cultures.

It will be observed that the amount of water absorbed per gram of air-dry seed in the cultures with the highest concentration is considerably less than that in the cultures with the lowest concentration or than that in the control cultures. The retarding influence of salt concentration on water absorption by seeds is here clearly brought out.

While germination was not prevented by the higher salt concentrations, it was considerably retarded; that is, the higher the concentration of the solution added to the sand culture the greater was the time required for germination to take place. Retarded germination seems to be directly related to the amount of water absorbed by the seeds, which in turn is dependent upon the concentration of the soil solutions. While seed germination was not actually prevented by the highest concentration here employed (8.0 atmospheres of possible osmotic pressure), injury to the root tips occurred after germination had taken place, even in concentrations (of solutions added to the sand culture) as low as 2.0 atmospheres of possible osmotic pressure.

Experiments in which a more complete series of salts is employed, and in which the solutions have a greater range of concentration, are now being conducted. These experiments include also series which make use of mixed solutions forming complete nutrient media, at concentrations limited by the solubility of the mixtures.

IX

INHERITANCE STUDIES WITH GARDEN PLANTS

EARLE J. OWEN

The problems in hand this season are grouped under the four headings: Beans, Eggplants, Limitation Studies and Okra.

Beans

The work with beans for 1916 embraced 9 commercial varieties, as representative parents and material for further breeding, and 15 F^1 crosses obtained in 1915, besides 5 F^2 crosses, 3 of which were reciprocals (R)*, one the Hudson Wax—Kentucky Wonder group, and the fifth the Scarlet Runner—Refugee Wax set. One plot was given over to a continuation of the Prolific—Non-Prolific tests, a complete record of which is not available at this writing. New crosses were obtained among the several varieties in hand and the reciprocals are now growing at the greenhouse for a detailed study, while, at the same time, gaining a generation for another year's work. The Limitation Set was given its usual attention, and altogether about 1,300 bean plants were under observation.

First Generation Crosses. There were 5 combinations, in each of which the Black Turtle Soup was a parent. This variety is a late, green-podded,

*The initial "R" when used hereafter will signify "Reciprocal."

black-seeded sort, and, in breeding, yields offspring (F^1) remarkable for vigor and productiveness, while the seeds are black even when the other parent is white. *As a rule the F^1 seed resulting from the union of a black* and a white-seeded bean is mottled. In crosses between a black and a red-seeded sort, of which Pencil Pod Wax–Flageolet Wax is an instance, a black seed results in the first generation, and in the F^2 brown appears in addition to the parental colors, red and black.

Second Generation Crosses. Crystal Wax–Hodson Wax (145-185, 185–145 F^2) *R.* This set was represented by 114 plants that gave a wide range of variation in respect to size and season, all inheriting the quality of productiveness from both parents and none requiring poles. The entire plant stem in many instances (25 per cent) was purplish, being associated with a purplish pod and either a dark-mottled or a black seed.

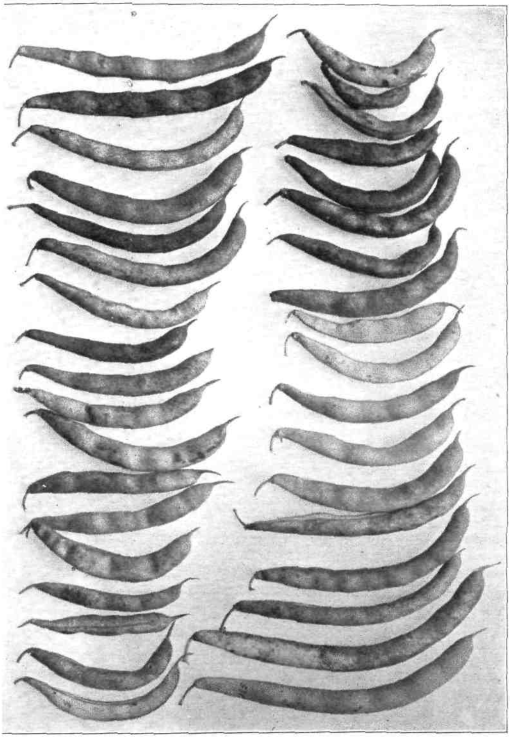
In Plate X the upper row represents Crystal Wax, as the male parent, at the left and Hodson Wax, the female parent, at the right. Each of the sixteen fruits between these two was picked from a separate plant, the motive being to show variation in size and shape. In the lower row the parentage is reversed, and a wider range in size and curvature is shown than in the reciprocal set above. The distinction between Crystal and true wax is not made by the camera, but the purplish-green pods are readily distinguished by their darker hue. At least 75 per cent of this set are green pods and may be associated with any color of seed from black through the mottled and browns to white. The seed color record was listed as follows: black, 38 per cent; brown, 14 per cent; dark mottled, 19 per cent; mottled-brown, 18 per cent; Hodson Wax type, 5 per cent, and white, 16 per cent.

"Hodson Wax"–"Kentucky Wonder" (185–260 F^2). This cross, aside from its scientific value, promises to be one of economic importance, uniting as it does two excellent varieties, a bush wax and a popular green-podded pole bean. From the seed of last year's plants (F^1) 173 offspring were grown. The number of pole individuals was decidedly in the majority, only 11 per cent being of the bush type.

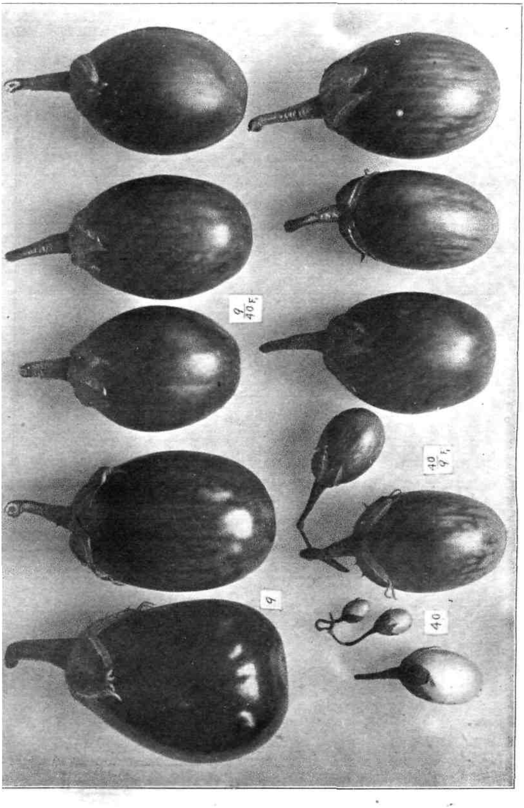
Eleven per cent of the plants bore wrinkled pods resembling Kentucky Wonder, 43 per cent were intermediate in form and 45 per cent resembled Hodson Wax in shape. In general the plants were prolific, and certain ones bore very attractive wax pods with the brittleness of Kentucky Wonder.

"Scarlet Runner"–"Refugee Wax" (63–137 F^2). Of the 109 plants in this group, 31 per cent were true pole plants, making a rank growth, and, as a rule, were late in season. Twenty-one per cent were intermediate in size, several being sterile. Forty-seven per cent were of the bush habit, including those classed as "abnormal"; that is, they either died or remained in a stunted condition. Concerning productiveness, 26 per cent were sterile, 27 per cent prolific and 47 per cent non-prolific. Since the Scarlet Runner has a fleshy or tuberous root, a record of root habit was made and 56 per cent were found similar to the wax parent, 41 per cent were classed as large rooted, and but 3 per cent had tuberous roots. Only four plants yielded wax pods, the remainder representing varying shades of green, some of which were striped or mottled. Pods of certain individuals approached the Scarlet Runner in form and size, the greater number were intermediate, while less than 25 per cent were as

PLATE X



Crossed Beans—Crystal Wax upon Hodson Wax.



Crossed Eggplants—New York Improved and Egg F_2.

small as Refugee Wax. The principal seed colors were black and mottled purple. For a study of the third generation selection has been made, especially of the more pronounced types in respect to plant habit, pod and seed characters, productiveness and root formation.

Eggplants

The experiments under this heading were concerned with over 400 plants, embracing 13 commercial varieties, including the Scarlet Chinese and a new species from Panama, 16 crosses and 5 hybrids of the first generation, besides 10 crosses and 3 hybrids of the second generation. Aside from the Panama eggplant the commercial types have been previously described.

The Panama, as grown for the first time this season, has the following *record: height 3 to 4 feet, stem and foliage green, leaves large and woolly,* spines very pronounced and numerous, occurring on stem, leaf and calyx; the flowers, borne in clusters of 3 to 7, are of a deep purple, with long, slender, curling petals, suggesting the Nightshade. The fruit, borne either singly or in clusters of two or more, has the appearance of an inverted pear, *and is pea-green in color, shading to a darker green at the tip, while at* maturity darker green stripes appear at the basal end. When fully mature the surface is yellow and may be indented like a rubber ball. From a breeding standpoint this species has peculiar interest, and efforts are being made to unite it with the Scarlet Chinese as well as the American varieties.

First Generation Crosses. New York Improved–Egg (9–40, 40–9 F^1) R. From the standpoint of heredity the above combination has most value, being the one reciprocal out of the entire 16 crosses. Plate XI shows at the left the male parent—New York Improved (9), a specimen below the average in size. Just below are fruits of the female parent Egg (40), showing its habit of forming fruits in clusters, which is inherited by the cross, as the two joined fruits at the right show. The main difference between the reciprocals is that of size, the 9/40 averaging 251.2 gm. in *weight of fruit, and 40/9 169.5 gm. The habit of forming fruit clusters is* much less pronounced in the case of 9/40. In general the F^1 crosses were more vigorous in growth and more productive than the F^2.

Second Generation Crosses. The fruits of this group have been studied in respect to size, shape, color, spinoseness and quality.

Size. In this generation more small fruited plants result, the large parent seldom being duplicated.

Shape. The pear form of Dwarf Purple is recessive to a type like the Long Purple, an oval shape being the usual result (F^1), with the pear appearing again in the second generation. The Round Purple has a marked *effect on the contour of all its offspring.*

Color. Ivory, which is always hidden by purple in the first generation, appears again in the second. Both a greenish-white color and a dull purple slashed with green crop out. A striped form similar to the commercial sort has appeared in the combination of Florida High Bush and Round White. The Striped, when a parent, behaves as a recessive. A peculiar shade ("lilac") sometimes appears when white is a parent (Long Purple–Egg), but it has not yet been fixed as a strain.

Quality. That the bitterness of the Scarlet Chinese can be eliminated from certain of its offspring when united with the American species has been demonstrated, and when good quality shall be joined with productiveness and spinelessness a most desirable result will be reached. Since all the recent combinations with Scarlet Chinese have come from a spineless strain, all F^1 plants have been spineless, and all the second generation individuals this season have possessed this character. Here, then, is the foundation for a marketable spineless fruit.

First Generation Hybrids. Of the five sets Scarlet Chinese-Round Purple stood first in respect to vigor, the plants reaching a height of 5½ feet but averaging scarcely 2 fruits to a plant. The plants of Round Purple-Scarlet Chinese and Striped-Scarlet Chinese were all sterile. The Dwarf Purple-Scarlet Chinese individuals were similar to those of last year in habit and yield of fruit.

Second Generation Hybrids—Ninety plants of the Dwarf Purple-Scarlet Chinese group were studied, showing the usual variation in respect to size (50–125 cm.). The leaf size was quite as variable. None of the plants were spiny, while most of the fruits approached the Scarlet Chinese in size. Concerning productiveness, the following percentages were obtained: Sterile, 12 per cent; non-prolific, 53 per cent; prolific, 34 per cent. Here is material for a study of inheritance in respect to bearing quality.

Limitation Studies

Subject.	*Number of Plants Grown.*	*Blooms Per Plant.*	*Pods Per Plant.*	*Seeds Per Pod.*	*Weight of One Seed Gm.*
Peas.					
Alaska F. C.,*	10	8.2	4.4	4.04	.180
One pod, ...	8	8.7	1.0	4.30	.200
No pods, ...	7	6.1	....	....	....
American Wonder F. C.,	7	10.8	2.5	3.50	.277
One pod, ...	5	10.2	1.0	4.20	.318
No pods, ...	5	10.8	....	....	....
Beans.					
Black Valentine F. C., ..	10	19.3	11.9	4.30	.289
One pod, ...	10	57.8	1.0	3.50	.410
No pods, ...	10	64.3	....	....	....
Davis Wax F. C., ...	10	29.6	9.7	4.50	.390
One pod, ...	6	51.0	10.0	6.30	.625
No pods, ...	10	69.5	....	....	....

* F. C. signifies Full Crop.

In this experiment the peas have been carried to the third and the beans to the eighth generation. With the former, when the fruit is limited to one, the difference in number of blooms is not nearly so marked as with

the beans, largely because peas have a shorter season and refuse to continue their growth during hot weather. On the other hand, a bean plant, if kept from fruiting, has a tendency to remain green until autumn.

The number of seeds per pod, with the exception of Black Valentine, shows an average increase when limited to one fruit. Thee weight of a seed from 1-podded plants is greater in every instance.

Okras

Including the Golden Bowl and its hybrids, the okras were represented in the field by 263 plants. The 3 commercial types, Dwarf Prolific, White Velvet and Dwarf Early Green, were grown again and comprised 46 plants. Thirty-two individuals made up the first generation crosses, which were Dwarf Purple–White Velvet (1/8) and Dwarf Early Green–Dwarf Prolific (15/1). All pods of the former were dehiscent at maturity. The White Velvet is a non-dehiscent sort.

Five plants of the Golden Bowl (*Hibiscus Manihot*) were grown and held their reputation for late flowering, the first blooms appearing about October 1. A few pods from attempted crosses have matured and promise another hybrid. There were 42 hybrid plants, 16 of which were three-fourths okra. They were taller than the others, averaging 8 feet, while the leaves were larger and the stems thicker. The pods also were shorter and thicker. Many pods have been selfed both in the crosses and in the hybrids.

X

Variation and Inheritance Studies in Species of Cucurbita and Datura

Orville C. Schultz

The genetic investigations of the genus *Cucurbita* have been limited to 8 horticultural varieties of the species *C. pepo* L. The varieties selected were the three "bush" squashes, Mammoth White Scallop, Long Island Scallop and Golden Summer Crookneck, the "vining" squash Cocoanut and the gourds, White Egg, Pear, Apple and Mock Orange. Pedigreed lines of each of these varieties are being established.

During the current year the first generations of the following crosses were grown: Three different crosses of Long Island Scallop x Cocoanut and three of Cocoanut x Long Island Scallop, one pair of which was a true reciprocal cross,* one Golden Crookneck x Long Island Scallop, four different Golden Crookneck x Mammoth White Scallop families and one Mammoth White Scallop x Golden Crookneck (not a true reciprocal of any Golden Crookneck x Mammoth White Scallop crosses); three Golden Crookneck x Cocoanut; one White Egg x Long Island Scallop; one White Egg x Apple and one Apple x White Egg (not true reciprocals); one White Egg x Mock Orange and its true reciprocal; one White Egg x Pear and one Pear x White Egg. (In these crosses the same White Egg plant

* The term "true reciprocal" is employed only in A x B and B x A crosses, when the A's and the B's, respectively, are the same plants.

was used both as pollen and seed parents, but the Pear parents were two different plants.) During this season many other crosses between the 8 varieties were made, among which are a number of true reciprocals.

The data on variability of fruits and seeds that have been collected thus far are being analyzed biometrically. We find that if we take into account all the fruits on the plant, we get characteristic frequency distributions for the different sizes of fruits and of the numbers and sizes of seeds produced. The problem is to determine, as far as possible, by meeans of a biometrical analysis the biological factors that result in these characteristic distributions. More specifically, it seems desirable to study such questions as the following:

1. The relation between the size and form of a given part and its position in the organism as a whole.

2. The relation of such a positional differentiation to the variation and correlation of the differentiated parts.

3. The relationship between intra-individual and intra-racial variation and correlation.

Although the data for the first generation of the cucurbit crosses have not been analyzed, the obvious results may be stated briefly as follows:

1. The Long Island Scallop and Cocoanut crosses produce fruits of two types with respect to color. Some are a creamy yellow while others are a lighter shade of yellow crossed by dark green stripes and marked by angular green spots. The striped fruits are uniformly larger than the yellow fruits. As to shape of fruit, the F^1 resembles the Long Island Scallop parent. The length of vine is also much less in the F^1 than in the Cocoanut parent, and, furthermore, it is not much greater than in Scallop parent.

2. The Golden Crookneck x Long Island Scallop cross produces jug-shaped fruits, white in color and more or less warty. The fruits of the Crookneck and Mammoth White Scallop crosses are similar to the Long Island Scallop cross, except that the yellow of the Crookneck parent is evident.

3. The fruits of the Cocoanut and Golden Crookneck crosses are straight, yellow, only faintly striped and with a swelling near the middle of the fruit.

4. In the White Egg and Long Island Scallop cross the reduction in the vine-length of the White Egg parent is very evident. In shape the fruits are similar to the Scallop parent, while the size is intermediate between the two parents.

5. In the crosses between the White Egg and the Mock Orange, Apple and Pear gourds, the fruits all resemble the Egg in size and color and also quite generally in shape.

Owing to the exceedingly great variability in the fruits of this species and the apparently great interaction between size and form factors, the genetic analysis of these crosses is a difficult task.

During last year a row of each of the following was grown: *Datura stramonium* L., *D. tatula* L., *D. meteloides* D. C., and *D, cornucopia*. This year the list was extended by the following: *D. metel*, *D. Wrightii* Hort., *D. fastuosa* L., *D. arborea* L.. and the Golden Queen. Many of these "species" and varieties were grown from commercial seeds Because many

horticultural names have been introduced to designate varieties which are not markedly differentiated, the value of some of the botanical names applied to many of the plants grown here may be very questionable. Seeds of *D. metel* were secured from two sources. One of these packets produced plants identical with *D. meteloides* D. C., but the other is true to name. *D. Wrightii* Hort. is probably closely related to *D. meteloides* D. C., but the two are sufficiently distinct not to be confused. *D. cornucopia* is probably a horticultural form of *D. fastuosa* L., although it differs from the latter in having only a double corolla and is much smaller and less vigorous. The "Golden Queen" is presumably a horticultural variety or *D. chlorantha* Hook. The Golden Queen stock of seeds produced plants having white flowers with double and triple corollas. The Golden Queen has a triple yellow corolla. During this year two plots of F^1 and F^2 plants of *D. stramonium* and *D. tatula* crosses were grown. In addition, a number of new crosses were secured.

On the basis of the results of hybridizing the Daturas the species may be arranged into three groups as follows:

1. *D. tatula* and *D. stramonium.*
2. *D. fastuosa, D. cornucopia* and *Golden Queen;*
3. *D. metel, D. meteloides* and *D. Wrightii.*

The species and varieties within each group hybridize readily, but all attempts so far to get hybrids between the members of one group with those of another group have failed.

The purple color of the *D. tatula* is transmitted as a single Mendelian factor.

The data on variability and correlation will be analyzed in a similar way as those for the squashes and gourds.

The genetic studies in Daturas are directed toward analysis of the factors involved in the inheritance of the size and form of various parts, color and spinosity.

REPORT OF THE DEPARTMENT OF ENTOMOLOGY

Department of Entomology

Thomas J. Headlee, Ph.D., *Entomologist.*
*Charles H. Richardson, Jr., M.Sc., *Assistant Entomologist.*
†Alvah Peterson, Ph.D., *Assistant Entomologist.*
§Henry H. Brehme, Field *Assistant in Entomology.*
**Charles S. Beckwith, B.Sc., *Assistant Entomologist.*
Augusta E. Meske, *Stenographer and Clerk.*

*Resigned September 15, 1916.
†Appointed October 1, 1916.
§Resigned January 31, 1916.
‡On State Station.
**Promoted from Field Assistant to Assistant Entomologist February 1, 1916.

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Report of the Department of Entomology

THOMAS J. HEADLEE

I

INTRODUCTION

The attention of the entomologist and his assistants has been devoted: (1) to the carrying on of correspondence with Jerseymen in need of information about the control of injurious insects or the management of beneficial ones, (2) to the investigation of the influence of atmospheric moisture upon insect metobolism; (3) to the investigation of the strawberry weevil, apple aphis, the false cabbage aphis, the pear psylla, and various miscellaneous species; (4) to the investigation of the efficiency of certain types of covers for wintering bees; (5) to the investigation of the food preferences of the common house or typhoid fly as a basis for making up an efficient poisoned bait; and (6) to the work of mosquito control.

II

CORRESPONDENCE

The following table serves to show the species about which inquiries were made. The number of letters relative to each species has been omitted because such data do not seem to serve any good purpose. The scientific names are those employed in "Insects of New Jersey," which was issued in 1909.

It is proposed to revise this list in 1919 and during the interim to use it as a standard. The changes in nomenclature are so rapid and extenive that it seems best to adopt something and stick to it.

Tabular Statement of Insect Correspondence, 1916

Latin Name	*Common Name*	*Locality*	*Date*
ANNELIDA			
Lumbricus sp.,	Earthworm,	Moorestown,	Mar. 9
" "	"	Westfield,	Nov. 14, '15
CRUSTACEA			
Isopoda sp.,	Sow Bugs,	Newark,	May 29

DIPLOPODA

Latin Name	*Common Name*	*Locality*	*Date*
Julus sp.,	Thousand-legged Worm,	Newton,	April 29
Diplopoda sp.,	" "	Newark,	May 5

ARACHNIDA

Eriophyes pyri Pgst.,	Pear-leaf Blister Mite,	Rutherford,	June 2
" " "	" " "	Bound Brook,	July 10
Eriophyes quadripes Shrimer,	Maple Gall Mite,	Ridgewood,	June 30
" " "	" " "	Short Hills,	May 31
Pediculoides dianthophilus,	Mite,	Sea Girt,	Nov. 8, '1
Pseudoscorpionida sp.,	Pseudoscorpion,	Millburn,	Oct. 9
Tetronychus sp.,	Red Spider,	Westwood,	Oct. 23
" "	" "	W. Englewood,	June 15
" "	" "	Mt. Holly,	June 16
" "	" "	Salem,	May 29
" "	" "	Caldwell,	April 13
" "	" "	Little Silver,	June 24
" "	" "	Nelsonville,	June 26
" "	" "	Short Hills,	Dec. 24, '1
" "	" "	Riverton,	Dec. 7, '1
" "	" "	Westfield,	Nov. 17, '1
Trombidium sp.,	Chigger,	Lebanon,	Sept. 15
Tyroglyphus sp.,	Mite,	Atlantic Highlands,	Sept. 7

INSECTA

Homoptera

Aphididæ sp.,	Plant Lice,	Tottenville, N. Y.,	Oct. 16
" "	" "	Princeton,	Sept. 16
" "	" "	Greenlock,	Sept. 9
" "	" "	Louisville, Ky.,	Nov. 9, '1
" "	" "	Morristown,	May 18
" "	" "	Hammonton,	June 24
" "	" "	Rahway,	June 8
" "	" "	Glassboro,	April 5
" "	" "	Oxford,	May 18
" "	" "	Paterson,	Nov. 29, '1
" "	" "	Phillipsburg,	June 1
" "	" "	Morristown,	June 4
" "	" "	Atlantic City,	June 6
" "	" "	Nutley,	June 10
" "	" "	Hackensack,	Mar. 30
" "	" "	Newark,	May 24
" "	" "	Elizabeth,	July 8
" "	" "	Atsion,	July 5
" "	" "	Rutherford,	July 24
" "	" "	Jersey City,	July 20
" "	" "	New Brunswick,	Nov. 17, '1
" "	" "	Riverton,	Dec. 7, '1
" "	" "	Moorestown,	Dec. 9, '1
" "	" "	Nutley,	June 9
" "	" "	Hackensack,	Sept. 23
" "	" "	Blue Anchor,	Feb. 14
" "	Aphid Gall,	New York City,	June 8
Aphis brassicæ Linn.,	Cabbage Louse,	Glassboro,	Sept. 20
" " "	" "	Allendale,	Mar. 30
" " "	" "	Monroeville,	Oct. 10

Latin Name	Common Name	Locality	Date
Aphis mali Fabr.,	Apple Plant Louse,	Dunellen,	April 17
" " "	" " "	Crosswicks,	Sept. 1
" " "	" " "	Sewell,	July 5
Aphis persicæ-niger Smith,	Black Peach Louse,	Brentwood,	Nov. 24, '15
Aphis pseudobrassicæ Davis,	False Cabbage Louse,	Freehold,	Oct. 12
Aspidiotus perniciosus Comst.,	San José Scale,	Elizabeth,	May 15
Aspidiotus perniciosus Comst.,	" " "	Caldwell,	April 24
Aspidiotus perniciosus Comst.,	" " "	New York City,	May 3
Aspidiotus perniciosus Comst.,	" " "	Leonia,	Jan. 22
Aspidiotus tsugæ Mar.,	Hemlock Scale,	Mahwah,	Feb. 19
Ceresa bubalus Fabr.,	Buffalo Tree Hopper,	Caldwell,	April 24
Chermes abietis Linn.,	Spruce Gall Louse,	Ridgewood,	May 9
Chermes pinicorticis Fitch,	Pine Bark Aphid,	Merchantville,	May 5
" " "	" " "	Ridgewood,	May 9
" " "	" " "	New Market,	June 25
Chionaspis euonymi Comst,	Euonymous Scale	Matawan,	May 9
Chionaspis pinifoliæ Fitch,	Pine-leaf Scale	Caldwell,	April 24
Coccidæ sp.,	Scale Insect,	Livingston,	April 26
" "	" "	Millington,	Oct. 18
" "	" "	Newark,	Oct. 16
Coccus pseudohesperidum,	Soft Scale,	Rutherford,	
Coccus hesperidum Linn.,	" "	Riverton,	April 8
Colopha ulmicola Fitch,	Coxcomb Elm Gall,	Red Bank,	May 30
Diedrocephala coccinea Forst.,	Leaf Hopper,	Passaic,	Oct. 3
Eulecanium nigrofasciatum Perg.,	Terrapin Scale,	Morristown,	Mar. 1
Eulecanium nigrofasciatum Perg.,	" "	Elizabeth,	Mar. 22
Eulcanium tulipiferæ Cook,	Tulip Soft Scale,	Plainfield,	July 20
" " "	" " "	Metuchen,	Aug. 30
Jassidæ sp.,	Leaf Hopper,	Westwood,	Oct. 23
" "	" "	Morristown,	June 4
Lepidosaphes ulmi Linn.,	Oyster-shell Scale,	Newton,	July 18
" " "	" " "	Plainfield,	July 14
" " "	" " "	Plainfield,	April 28
" " "	" " "	Mendham,	April 26
" " "	" " "	Sebago Lake, Me.,	Mar. 30
" " "	" " "	Leonia,	Jan. 22
Longistigma caryæ Harr.,	Aphid,	Merchantville,	Sept. 28
Macrosiphum pisi Kalt.,	Pea Louse,	Riverton,	Oct. 1
" " "	" "	Hightstown,	June 16
Myzus cerasi Fabr.,	Cherry Louse,	Crawford,	July 15
" " "	" "	Newark,	May 15
Pemphigus vagabundus Walsh,	Aphid Gall,	Newton,	July 18
Phyllaphis fagi Linn.,	Wooly Beech Aphis,	Edgewater Park,	June 27
Phylloxera caryæ-caulis Fitch,	Aphis Gall,	Bloomfield,	June 12
Psylla pyricola Forst.,	Pear Psylla,	Vineland,	April 13
Pulvinaria acericola W. & R.,	Cottony Maple Scale,	Hammonton,	June 24
Saissetia hemisphaerica Targ.,	Hemispherical Scale,	Cedar Brook,	Dec. 31, '15
Saissetia hemisphaerica Targ.,	" "	Rutherford,	Feb. 11
Trioza magnolia,	Psyllid,	Rutherford,	June 15

Hemiptera

Latin Name	*Common Name*	*Locality*	*Date*
Anosa tristis DeG.,	Squash Bug,	Madison,	Oct. 17
Cimex lectularius Linn.,	Bed Bug,	Jersey City,	Nov. 16, '
" " "	" "	Moorestown,	Feb. 12
" " "	" "	Newark,	Mar. 23
" " "	" "	Palmyra,	Aug. 21
Leptobyrsa explanata Heid.	Rhododendron Lace Bug,	Jersey City,	Nov. 12, '
Stephanitis pyriodes Scott,	Lace Bug,	New York City,	Nov. 12, '

Orthoptera

**Blaberus discoidalis* Say,	Roach,	Secaucus,	
Blatta orientalis Linn.,	Oriental Cockroach,	Windsor,	June 30
Gryllus sp.,	Cricket,	Red Bank,	July 26
Oecanthus fasciatus Fitch,	Tree Cricket,	Caldwell,	April 24

Coleoptera

Anthonomus signatus Say,	Strawberry Weevil,	Frankford, Del.,	Dec. 2, '1
" " "	" "	Pleasantville,	June 14
" " "	" "	Elmira, N. Y.,	June 1
" " "	" "	Kulpsville, Pa.,	May 8
" " "	" "	Millville,	May 8
" " "	" "	North East, Pa.,	May 6
" " "	" "	Wading River,	May 1
" " "	" "	Millville,	April 8
" " "	" "	Bridgeville, Del.,	April 6
" " "	" "	Moorestown,	Mar. 9
" " "	" "	Merchantville,	Mar. 6
" " "	" "	Bridgeton,	Feb. 24
" " "	" "	Medford,	Mar. 21
" " "	" "	Bridgeville, Del.,	Feb. 14
" " "	" "	Merchantville,	Dec. 12, '1
Balaninus rectus Say,	Chestnut Weevil,	Beverly,	Mar. 6
Bruchus obtectus Say,	Bean Weevil,	May's Landing,	Sept. 9
Calandra oryzæ Linn.,	Rice Weevil,	Laurel Springs,	Aug. 23
Calandra sp.,	Grain Weevil,	May's Landing,	Oct. 18
Cathartus advena Walth.,	Foreign Grain Weevil,	Atlantic Highlands,	Sept. 7
Cerambycidæ sp.,	Long-honed Borer,	New Brunswick,	July 19
" "	" "	Ridgewood,	June 17
Ceratoma trifurcata Forst.,	Bean-leaf Beetle,	Glen Gardner,	June 3
Chrysomelidæ sp.,	Flea Beetle,	Hackensack,	Sept. 23
Coccinellidæ sp.,	Lady Bird Beetle,	Atlantic City,	June 6
Conotrachelus nenuphar Hbst.,	Plum Curculio,	New York City,	Dec. 10, '15
Conotrachelus nenuphar Hbst.,	" "	Belmar,	May 16
Conotrachelus nenuphar Hbst.,	" "	East Orange,	May 11
Conotrachelus nenuphar Hbst.,	" "	Burlington,	June 7
Conotrachelus nenuphar Hbst.,	" "	Elizabeth,	May 19
Conotrachelus nenuphar Hbst.,	" "	South River,	June 17
Conotrachelus nenuphar Hbst.,	" "	Cresskill,	July 7
Crioceris asparagi Linn.,	Asparagus Beetle,	Glassboro,	June 2
" " "	" "	Mendham,	June 5
" " "	" "	Summit,	Sept. 4

* New insects for New Jersey.

Latin Name	Common Name	Locality	Date
Diabrotica vittata Fab.,	Striped Cucumber Beetle,	New York City,	April 4
" " "	" " "	Glen Gardner,	June 3
" " "	" " "	Moorestown,	July 24
Dermestidæ sp.,	Dermested,	Cape May Court House,	Sept. 12
Desmocerus palliatus Forst.,	Long-horned Beetle,	New York City,	June 27
Ecdytolopha insiticiana Zell.,	Locust Twig Borer,	Spring Lake,	Sept. 9
Elaphidion villosum Fab.,	Maple & Oak Twig Pruner,	Vineland,	Sept. 29
Elateridæ sp.,	Wire Worm,	Little Falls,	Dec. 14, '15
" "	" "	Hackettstown,	April 23
Epitrix cucumeris Harr.,	Potato Flea Beetle,	South River,	Jan. 27
" " "	" " "	Phillipsburg,	May 24
" " "	" " "	New Brunswick,	July 19
" " "	" " "	Elmer,	May 23
" " "	" " "	Allentown,	May 31
" " "	" " "	Bernardsville,	May 31
" " "	" " "	Phillipsburg,	June 1
" " "	" " "	South River,	June 17
" " "	" " "	Rocky Hill,	June 20
Lachnosterna sp.,	White Grubs,	Madison,	Feb. 5
" "	" "	Philadelphia, Pa.,	May 16
" "	" "	W. LaFayette, Ind.,	June 5
" "	" "	W. Englewood,	June 15
" "	" "	Jersey City,	July 18
Leptinotarsa decemlineata Say,	Colorado Potato Beetle,	Glassboro,	June 2
Leptinotarsa decemlineata Say,	" " "	Paterson,	June 16
Leptinotarsa decemlineata Say,	" " "	Perth Amboy,	July 14
Leptinotarsa decemlineata Say,	" " "	Manchester, Conn.,	July 11
Leptinotarsa decemlineata Say,	" " "	Oradell,	July 11
Macrodactylus subspinosus Fabr.,	Rose Chafer,	Glendola,	Nov. 11, '15
Macrodactylus subspinosus Fabr.,	" "	Bayonne,	May 28
Macrodactylus subspinosus Fabr.,	" "	Plainfield,	May 7
Macrodactylus subspinosus Fabr.,	" "	Carmel,	May 2
Monarthrum mali Fitch,	Scolytid Beetle,	Rutherford,	May 29
Nodonota puncticollis Say,	Beetle,	Princeton,	June 27
Oncideres cingulatus Say,	Hickory Twig Girdler,	High Bridge,	Oct. 9
Phytonomus punctatus Fabr.,	Clover-leaf Beetle,	Trenton,	Sept. 8
Pissodes strobi Peck,	White Pine Weevil,	Far Hills,	Sept. 20
" " "	" " "	Rutherford,	June 24
" " "	" " "	Ridgewood,	May 25
" " "	" " "	Sterlington, N. Y.,	Jan. 26
Plagionotus speciosus Say,	Sugar Maple Borer,	Cranford,	Sept.
Polyphylla variolosa Henty,	Scarabaeid,	Ocean City,	Nov. 17, '15
Scolytus quadrispinosus Say,	Hickory Bark-borer,	Plainfield,	June 26
" *rugulosus* Ratz,	Fruit-tree Bark-beetle,	Paterson,	June 10
Silvanus surinamensis Linn.,	Corn Silvanus,	Trenton,	Nov. 6, '15

Lepidoptera

Latin Name	Common Name	Locality	Date
Ancylis comptana,	Strawberry Leaf Roller,	Sewell,	June 16
Anisota senatoria Sm. & Abb.,	Oak Worm,	Richmond, Mass.,	Sept. 25

Latin Name	*Common Name*	*Locality*	*Date*
Arctiidæ sp.,	Arctiid Moth,	Berlin,	Aug. 29
Carposapsa pomonella Linn.,	Codling Moth,	New Brunswick,	May 16
**Castnia therapon* Kall.,	Hesperid (in greenhouse),	Bound Brook,	Feb. 2
Citheronia regalis Fabr.,	Hickory Horned Devil,	Woodbine,	Sept. 18
Datana integerrima G. & R.,	Walnut Datana,	Hasbrouck Heights,	Aug. 28
" *ministra* Dru.,	Yellow-necked caterpillar,	Chatham,	Sept. 1
Desmia funeralis Hubnr.,	Grape-leaf Folder,	Hackensack,	June 2
" " "	" " "	Bridgeton,	Oct. 8
Euclea indetermina Bdv.,	Slug Caterpillar,	Englewood,	Sept. 22
" " "	" "	Lyndhurst,	Sept. 11
Heliothis armiger Hbn.,	Corn Ear-worm,	Westfield,	Sept. 18
" " "	" " "	Goshen,	Mar. 22
" " "	" " "	New York City,	May 19
" " "	" " "	Moorestown,	July 24
Hemerocampa leucostigma S. & A.,	White-marked Tussock Moth,	Englewood,	Oct. 23
Hemerocampa leucostigma S. & A.,	" " " "	Camden,	Dec. 2, '1
Hemerocampa leucostigma S. & A.,	" " " "	Camden,	Dec. 4, '1
Hyphantria cunea Dru.,	Fall Web-worm,	Dover,	Sept. 13
Limenitis archippus Cram.,	Nymphalid Butterfly,	Newton,	Aug. 29
Malacosoma americana Fabr.,	Apple Tree Tent Caterpillar,	Elizabeth,	Mar. 22
" " "	" " " "	White Plains, N. Y.,	Mar. 2
" " "	" " " "	Newark,	Feb. 23
" " "	" " " "	Hampton,	Feb. 23
" " "	" " " "	New York City,	May 23
" " "	" " " "	Rahway,	June 5
" " "	" " " "	Avalon,	May 24
" " "	" " " "	Far Hills,	April 27
" " "	" " " "	Dover,	Jan. 28
" " "	" " " "	Bridgeton,	April 29
" " "	" " " "	Millburn,	June 16
" " "	" " " "	Stockton,	June 8
Marmara salictella Clem.,		Montclair,	Sept. 14
Melittia satyriniformis Hbn.,	Squash Vine Borer,	Phillipsburg,	Aug. 25
" " "	" " "	Silverton,	June 8
Noctuidæ sp.,	Cut Worms,	Trenton,	Oct. 7
" "	" "	New York City,	Nov. 4, '1
" "	" "	Dorchester,	June 12
Oxyptilus periscelidactylus Fitch,	Grape Plume Moth,	East Orange,	June 13
Papaipema nitela Gn.,	Stalk Borer,	Atco,	July 25
" " "	" "	Allendale,	July 10
" " "	" "	Hamburg,	July 5
Papilio polyxenus Fabr.,	Celery Caterpillar,	Frenchtown,	July 16
Pegomyia brassicæ Bouche,	Cabbage Maggot,	Vineland,	Oct. 25
Peridroma margaritosa Haw.,	Variegated Cut Worm,	Trenton,	Nov. 24, '1
Philosamia cynthia Dru.,	Moth,	Belvidere,	June 27
Phobetron pithecium S. & A.,	Hag Moth,	W. Milford,	Sept. 9
Phlyctaenia rubigalis Guen.,	Greenhouse Leaf Tier,	W. Norwood,	Mar. 23
Pieris rapæ Linn.,	Cabbage Worm,	Allendale,	Mar. 30
" " "	" "	Bloomfield,	July 18
Porthetria dispar Linn.,	Gipsy Moth,†	Newark,	June 6
Prolimacodes scapha Harr.,	Slug Caterpillar,	New Egypt,	Sept. 1
Samia cecropia Linn.,	Cecropia Moth,	Hackensack,	

* New insects for New Jersey.

† Request for warning cards.

Latin Name	*Common Name*	*Locality*	*Date*
Sanninoidea exitiosa Say,	Peach Borer,	Merchantville,	Nov. 11, '15
" " "	" "	Glassboro,	April 22
" " "	" "	Millville,	April 4
" " "	" "	Burlington,	May 10
" " "	" "	Brookside,	June 5
" " "	" "	Paterson,	June 1
" " "	" "	Summit,	July 25
" " "	" "	Plainfield,	Nov. 22, '15
" " "	" "	Robbinsville,	Nov. 24, '15
" " "	" "	Roselle,	Jan. 5
" " "	" "	New York City,	Dec. 28, '15
" " "	" "	Delanco,	Nov. 29, '15
" " "	" "	Woodbine,	Feb. 1
" " "	" "	Allendale,	Mar. 28
" " "	" "	May's Landing,	Sept. 15
" " "	" "	Newton,	Sept. 15
" " "	" "	Trenton,	July 6
Sitotroga cerealella Oliv.,	Angoumois Grain Moth,	Laurel Springs,	Aug. 23
" " "	" " "	Cape May Court House,	Sept. 12
Thyridopteryx ephemeraeformis Steph.,	Bag Worm,	Mount Holly,	July 14
Thyridopteryx ephemeraeformis Steph.,	" "	Lakewood,	Sept. 8
	Hymenoptera		
Apis mellifica Linn.,	Honey Bee,	Branchville,	Nov. 5, '15
Cimbex americana Leach,	Willow Saw-fly,	Newark,	June 23
**Diprion simile* Hartig,	European Pine Saw-fly,	Elizabeth,	
" " "	" " " "	Rutherford,	
" " "	" " " "	South Orange,	
Eriocampoides limacina Retz.,	Pear Slug,	Pleasantville,	June 28
Eriocampoides limacina Retz.,	" "	New Brunswick,	July 7
Eriocampoides limacina Retz.,	" "	Burlington,	July 11
Exartema permundana Clem.,	Raspberry Leaf-roller,	Grantwood,	Mar. 25
Formicidæ sp.,	Ants,	Teaneck,	June 2
" "	"	East Orange,	June 6
" "	"	Somerville,	May 22
" "	"	Elizabeth,	May 6
" "	"	Flemington,	May 2
" "	"	Paterson,	June 7
" "	"	Elizabeth,	July 11
**Janus abbreviatus* Say,	Saw-fly,	Bound Brook,	July 2
" " "	" "	Elizabeth,	July 8
" " "	" "	Irvington,	July 20
" " "	" "	South Orange,	July 14
" " "	" "	Springfield,	July 25
Ophion sp.,	Ichneumon Fly,	Montclair,	Sept. 14
Pteronus ribesi Scop.,	Imported Currant Worm,	Staten Island, N. Y.,	May 28
Tenthredinidæ sp.,	Saw-fly,	Mahwah,	Sept. 20
" "	" "	Middlebush,	May 31
Vespa crabro Linn.,	European Hornet,	Blackwood,	Oct. 23
	Siphonaptera		
Ctenocephalus canis Linn.,	Cat and Dog Flea,	Cream Ridge,	June 5
" " "	" " " "	Newark,	May 24
" " "	" " " "	Medford,	June 6
Pulex irritans Linn.,	Human Flea,	Cream Ridge,	June 5

* New insects for New Jersey.

Diptera

Latin Name	Common Name	Locality	Date
Acidia sauvis Lowe,	Trypetid,	Bridgeton,	Mar. 24
Anopheles sp.,	Malaria Mosquito,	New Brunswick,	July 19
Bibionidæ sp.,	Fly,	Irvington,	May 24
Cecidomyia pomum Walsh,	Cecidomyid,	Flemington,	Sept. 13
Cecidomyiidæ sp.,	Galls,	Dunellen,	Aug. 7
Culicidæ,	Mosquitoes,	Avalon,	May 24
"	"	Belmar,	June 15
"	"	Blythe, Cal.,	Mar. 15
"	"	Boonton,	Feb. 25
"	"	Boston, Mass.,	April 24
"	"	Caldwell,	Feb. 12
"	"	Cliffside,	Nov. 27, '15
"	"	Concord,	May 5
"	"	Demarest,	Dec. 17, '15
"	"	Elwood,	Feb. 18
"	"	Highland, N. Y.,	May 18
"	"	Ithaca, N. Y.,	May 9
"	"	New Brunswick,	May 8
"	"	New Haven, Conn.,	May 29
"	"	New Haven, Conn.,	June 10
"	"	New York City,	June 15
"	"	" " "	May 26
"	"	" " "	June 19
"	"	" " "	Feb. 10
"	"	" " "	Jan. 30
"	"	" " "	Jan. 27
"	"	" " "	Nov. 21, '15
"	"	Palmerton, Pa.,	May 13
"	"	Penns Grove,	June 5
"	"	Trenton,	April 26
Dasyneura leguminicola Lint.,	Fly,	Newton,	June 27
Lasioptera vitis P. S.,	Potato Gall,	Mahwah,	June 22
" " "	" "	Beach Haven,	June 17
" " "	" "	Elizabeth,	June 22
" " "	" "	Nutley,	June 15
Meromyza americana Fitch.,	Wheat Bulb-worm,	Cream Ridge,	June 13
" " "	" " "	Newton,	July 13
**Monarthropalpus buxi* Lab.,	Box-leaf Miner,	Rumson,	Nov. 21, '15
Musca domestica Linn.,	House Fly,	Highland, N. Y.,	May 18
" " "	" "	St. Paul, Minn.,	Mar. 19
" " "	" "	Boonton,	Feb. 25
" " "	" "	New York City,	July 25
" " "	" "	Summit,	July 12
" " "	" "	Far Hills,	April 27
" " "	" "	Penns Grove,	June 5
**Parallelodiplosis cattleya* Moll.,	Orchid Midge in greenhouse,	Chatham,	Jan. 18
Pegomyia brassicæ Bouche,	Cabbage Maggot,	Garwood,	May 29
Phytomyza aquilegiæ Hardy,	Columbine Leaf Miner,	Springfield,	July 6
" " "	" " "	Rutherford,	July 29
" " "	" " "	Riverton,	July 18
" " "	" " "	Elizabeth,	July 3
Pollenia rudis Fabr.,	Muscid,	Hamburg,	Sept. 17
Rhagoletis pomonella Walsh.,	Apple Maggot,	New York City,	Nov. 16, '15
Sciara sp.,	Sciara Army Worm,	Bound Brook,	July 25

* New insects for New Jersey.

The volume of correspondence this year has been much the same as last, but with an evident increase. Not far from an average of 25,[1] letters have been sent out from the office each working day. The correspondence related to 146 species of insects and their near relatives of which 25 were species of mosquitoes.

III

INSECTS OF THE YEAR

Some notion of the species which were troublesome may be obtained by consulting the tabular statement of insect correspondence, but neither the species excessively abundant nor those which are new to the State get sufficient emphasis in a statement of this sort.

Tent Caterpillar

(*Malacosoma americana* Harr.)

The tent caterpillar was again sufficiently abundant to constitute an outbreak, although the amount of damage was considerably lessened. The distribution of the outbreak was this year about the same as last—mainly in the northern part of the State, with its greatest severity in the northeastern section, but it was present to some extent in all parts of the State.

Apple Plant Lice

The principal, but not the only, species concerned has been the rosy aphis (*Aphis sorbi* Kalt.). To a less extent the green aphis (*Aphis pomi* De Gr.) was a factor. The distribution of the rosy aphis was apparently general, and the damage done by it considerable. Especial attention was given to it by the entomologist in the orchards of Mr. John H. Barclay, of Cranbury, and of the J. L. Lippincott Co., of Riverton. In both cases completely satisfactory control was obtained. The results of this work are set forth under a special heading elsewhere in this report.

Pear Psylia

(*Psylla pyricola* Forst.)

During the last few years the damage done by this species appears to have been increasing. In 1914 Mr. J. C. Richdale, of Phalanx, complained of trouble with it in his Kieffer pear orchards, and sought out aid in controlling it. In 1915 the J. L. Lippincott Co., of Riverton, sought help in controlling the same species in its Kieffer orchards. In 1916 Mr. Wm. H. Blackwell complained of trouble in his Bartlett orchard at Titusville, and Mr. Lester Collins, of Moorestown, stated that not only was the psylla

[1] Last year the correspondence of the State entomologist was mentioned in speaking of the volume of correspondence. This year the correspondence of the State entomologist is not included.

injurious in his Kieffer orchards, but that his control had been unsatisfactory.

It seems that the species has, during the last few years, been experiencing one of its periodical increases in numbers, and consequently injurious power.

An account of the work done against it and of the results obtained will be found in another part of this report.

The False Cabbage Aphis

(*Aphis pseudobrassicae* Davis)

For several years the growers of turnips about Freehold have been troubled with a plant louse which has at times been so abundant as to destroy the crop. This year the matter was brought to the entomologist's attention by Mr. Wm. B. Duryea, the Monmouth County farm demonstrator.

The nature and the extent of the infestation were investigated, and the species, proving to be one of which we had no duplicate, was forwarded to Mr. John J. Davis and by him pronounced the false cabbage aphis. While this is the first time it has been taken in the State, there is little doubt in the writer's mind that the species has been present in injurious numbers for several and perhaps many years.

The nature and the results of the work done upon this species are set forth in a special section of this report.

The Oak Worm

(*Anisota senatoria* Smith and Abbott)

In the early fall the work of the oak worm attracted much notice. The outbreak seemed to be limited mainly to the scrub oak in the central portions of the State. Even in this area its distribution was patchy, defoliation appearing in many cases at widely separated points. All the common species of scrubby oak were attacked, but the birch seemed to be the only species other than the oak to suffer.

The attack came so late in the season that little real damage was done, the buds having been largely made before injury began.

The Rose Bug

(*Macrodactylus subspinosus* Fab.)

The species, while not so abundant this year as last, appeared in sufficient numbers to do serious harm. It is mentioned primarily because again this year the self-boiled lime-sulfur has satisfactorily protected apple foliage from injury.

The Elm Leaf Beetle

(*Galerucella luteola* Mull.)

This species has been remarkably reduced this year. The elms on the college campus were so little infested as not to require spraying.

Sciara Army Worm

(*Sciara sciaphila* Loew.)

On July 27 the entomologist investigated report of army worm trouble in Bound Brook. The army worms in question were really in every case aggregations of fungous gnat larvæ. The individual larvæ were a half-inch or less long but crowded so close together that they formed a con-

tinuous string, ranging from 2 inches to 24 in length. The largest ones were about 2 inches wide. These strings appeared immediately after soaking rains, on lawns, along stone, brick, and cement walks, as well as upon them, exciting the surprise and interest, and in some cases fear of those who saw them. The larvæ were identified by Dr. A. H. Johannsen as *Sciara sciaphila* Loew. They were fully grown and probably in search of a satisfactory place to pupate.

IV

SPECIES OF INSECTS RECENTLY RECORDED AS PRESENT IN THE STATE

First List

This list falls into two divisions. The first is concerned with species that are probably native, or at any rate not certainly known to have been imported. The second includes species definitely known to have been imported within the last ten or twelve years.

Order Thysanura

Achorcutes armatum Nicolet. The Mushroom Spring Tail. Occurs in mushroom cellars in New Jersey.

Order Mallophaga

Docophorus platyrhynchus Nitzsch. From *Buteo lineatus*. C. H. Richardson.

Order Neuroptera

Hesperoleon placidus Navas. Point Pleasant, July 25, Bueno. (B'klyn. Bul., v. 10, No. 3.)
Conwentzia hageni Banks. Rutherford, May 30, bred from evergreens, E. L. Dickerson.
Conwentzia angulata Navas. Westfield, August 31, de la Torre Bueno.

Order Mecoptera

Panorpa latipennis Hine. Hewitt, June 18, Davis. (Bul. B'klyn Soc., v. 10, p. 109.)
Panorpa subfurcota West. Ramsey, June 23; Hewitt, June 18; Davis. (Bul. B'klyn Soc., v. 10, p. 109.)
Merope tuber Newman. Chester, Dickerson. (Bul. B'klyn Soc., v. 10, p. 3.)

Order Trichoptera

Neuronia paradalis Walker. Lakehurst, June 5, 1909. L. B. Woodruff. (Jour. N. Y. Ent. Soc., v. 21, p. 163.)
Neuronia smithi, Banks. Lakehurst, July 4. Englehart.
Œcetina fumosa Bks. Pemberton, June 20. H. B. Scammell.
Plectrocnemia cinereus Hg. Pemberton, June 24. H. B. Scammell.

Order Odonata

Agrion æquabile Say. Great Notch, May 30. W. T. Davis. (Jour. N. Y. Ent. Soc., Mar., 1913.)
Lestes uncotus Kirby. Newfoundland, August 4. W. T. Davis. (Jour. N. Y. Ent. Soc., Mar., 1913.)
Enallagma recurvatum Davis. Lakehurst, June 28, 1913. W. T. Davis.
Enallagma cyathigerum Charpentier (*annexum* Hagen) Ramsey, May 20. (Jour. N. Y. Ent. Soc., Mar., 1913.)
Enallagma ebrium Hagen. Newfoundland, Lake Hopatcong, July. (Jour. N. Y. Ent. Soc., Mar., 1913.)
Gomphus abbreviatus Hagen. Greenwood Lake, June 18, 1911. F. M. Schott.
Cordulegaster erroneus Hagen. Bear Swamp, Ramapo Mts., August 18, 1910. Chas. E. Slight. (Jour. N. Y. Ent. Soc., Mar., 1913.)

Tetragoneuria spinigera Selys. Newfoundland, May 28, W. T. Davis; Greenwood Lake, June 30, Watson. (Jour. N. Y. Soc., Mar., 1913.)

Libellula exusta deplanata Rambur. Woodbury, May 14, 1912. P. Laurent.

Lanthus albistylus Hagen. Bear Swamp, Ramapo Mts., June, July. C. E. Slight. (Jour. N. Y. Ent. Soc., Mar., 1913.)

Williamsonia lintneri Hagen. Paterson, May 4, J. A. Grossbeck. (Bul. B'klyn Ent. Soc., v. 8, p. 93.)

Order Thysanoptera

Cryptothrips gilvipes Hood. Pemberton, April, 1915. In cocoons of *Gelechia trialbamaculella*. H. B. Scammell.

Hoplothrips karnyi Hood. Pemberton, August 29, 1914, on dead tree. H. K. Plank.

Order Homoptera

Cicada auletes Germar. This should replace *C. marginata* Say of the 1909 list. (Jour. N. Y. Ent. Soc., v. 23, p. 2) Davis.

Cicada pruinosa var. *latifasciata* Davis. Cape May County, Davis. This record should replace *C. pruinosa* Say in the 1909 list. (Jour. N. Y. Ent. Soc., v. 23, p. 8) Davis.

Telomona querci. Summit, F. M. Schott.

Cyrtolobus tuberosus. Summit, F. M. Schott.

Phyllosceelis atra Germ. Harrisia, New Egypt. Three forms: black, long-winged; black, short-winged; brown, short-winged. Injurious to cranberry. H. B. Scammell.

Xestocephalus tessellatus Van D. Newark. E. L. Dickerson.

Chlorotettix galbanata Van D. Newark. E. L. Dickerson.

Livia vernalis Fitch. Trenton, July 2. E. L. Dickerson.

Pachypsylla celtidis-mammo Riley. Makes leaf galls on Celtis. Riverton, June 25. E. L. Dickerson.

Trioza alacris Flor. Rutherford, August 18. On bay trees.

Phylloxera fovela Pergande. New Brunswick and other parts of the State. Common on leaves of hickory. C. H. Richardson.

Pemphigus ulmifusus Walsh. Gall on leaf of *Ulmus pubescens*. H. B. Weiss.

Aphis hederæ Kalt. In greenhouses on English ivy. Not common. H. B. Weiss.

Aphis houghtonensis Troop. Riverton, on gooseberry. T. J. Headlee.

Aphis nerii Fonsc. In greenhouses on oleander. Not common. H. B. Weiss.

Aphis sorbi Kaltenbach. Throughout the State on apple. The rosy apple aphis. T. J. Headlee and C. H. Richardson.

Myzus rosarum Kalt. On roses in greenhouses. H. B. Weiss.

Macrosiphum sanborni Gill. Black aphis of chrysanthemum, in greenhouses. H. B. Weiss.

Aleyrodes mori Quaint. var. *maculata* Morr. Palmyra, August 6, on sweet gum. E. L. Dickerson.

Aleyrodes coryli Britton. Norwood, August, on hazel nut. H. B. Weiss.

Aleyrodes packardi Morrill. Westwood, May, 1915, on strawberry. G. Kircher.

Aleyrodes waldeni Britton. Somerville, July, on leaves of *Juglans* sp. H. B. Weiss.

Pseudococcus pseudonipæ Ckll. Occurs in greenhouses on *Kentia* sp. H. B. Weiss.

Coccus pseudohesperidum Ckll. Rutherford, South Orange, Summit, in greenhouses on Cattleya orchids and other greenhouse plants. H. B. Weiss.

Saissetia oleæ Bern. In greehouses on orange and lemon. H. B. Weiss.

Diaspis bromeliæ Kern. In greenhouses on pineapple. H. B. Weiss.

Aulacaspis zamiæ Morg. On *Cycas revoluta* in greenhouses. H. B. Weiss.

Aspidiotus britannicus Newst. In greenhouses on bay trees. H. B. Weiss.

Chrysomphalus tenebricosus Comst. Rutherford, Nov., 1912. On red maple. H. B. Weiss.

Ischnaspis longirostris Sign. Montclair, on palms in greenhuuses. H. B. Weiss.

Pseudaonidia paeoniæ Ckll. Riverton, Princeton. On Japanese azaleas. Not common. Probably introduced from Japan. H. B. Weiss.

Toumeyella pini King. Asbury Park, July 26, on pine. E. L. Dickerson and H. B. Weiss.

Eucalymnatus tesselatus Sign. On palms in greenhouses. H. B. Weiss.

Icerya purchasi Mask. In greenhouses on *Acacia* sp. H. B. Weiss.

Ceraplastes cirripediformis Comst. In greenhouses on citrus trees. H. B. Weiss.

Ceroplastes floridensis Comst. In greenhouses on citrous trees. H. B. Weiss.

Order Hemiptera

Banasa sordida Uhl. Madison. F. M. Schott.
Aradus shermani Heid. Lakehurst, May 25. Torre Bueno.
Lygidea mendax Reut. New Brunswick, High Bridge, Bridgeton and other parts of the state. False apple red bug.
Drymus crassus VanD. Camden. Torre Bueno.
Jalysus multispinosus Ashm. Lakehurst, Barber. (Jour. N. Y. Ent. Soc., v. 19, p. 23.)
Corythuca marmorata Uhl. Vineland, July 21. E. W. Stafford.
Ranatra kirkaldyi Bno. Totowa, July. Wintersteiner.
Acantholoma denticulata Stal. Schooley's Mt., May 20. F. L. Lutz. (Jour. N. Y. Ent. Soc., v. 20, p. 138.)
Pseudocnemodus canadensis Prov. Lakehurst, July 11. Davis. (Jour. N. Y. Ent. Soc., v. 19, p. 26.)
Sphaerobius quadristriata Barber. Lakehurst, July 4, Sept. 7. Davis & Barber. (Jour. N. Y. Ent. Soc., v. 19, p. 24.)

Order Orthoptera

Blaberus discoidalis Serv. New Jersey greenhouses. H. B. Weiss.
Pycnoscelus surinamensis Linn. Rutherford, in greenhouses. H. B. Weiss.

Order Coleoptera

Trechus borealis Schaeffer. New Jersey, Nicolay. (Jour. N. Y. Ent. Soc., Mar., 1915.)
Cercyon lateralis. Staten Island, May 25, 1908. Probably occurs in New Jersey. Davis.
Atheta virginica Brnhv. Vineland, March 10. H. B. Weiss.
Oxypoda (Sphenoma) obliqua Casey. Vineland, September 14, H. B. Weiss.
Philonthus varians Payk. Franklin Furnace, F. M. Schott. (Jour. N. Y. Ent. Soc., Mar., 1915.)
Sunius discopunctatus Say. Vineland, March 2. H. B. Weiss.
Baeocera concolor Fab. Vineland, March 2.
Phalacrus consimilis Marsh. Vineland, March 2.
Coccinella transversoguttata Fabr. Malaga, April 29, 1911. H. W. Wenzel.
Litargus nebulosus Lec. Vineland, March 2.
Ips cœlatus Eichh. Rutherford, May 10, 1915. In shoots of *Pinus mughus*. H. B. Weiss.
Monotoma parallela Lec. Anglesea, March. H. B. Weiss.
Sandalus niger. New Jersey Palisades. Nicolay.
Agrilus masculinus Horn. Newark. H. B. Weiss.
Agrilus crinicornis Horn. Newark. H. B. Weiss.
Trichodea nuttalli Kirby. Red Bank, July 4, 1908. Kaeber.
Dinoderus punctatus Say. Vineland, May 4. H. B. Weiss.
Aphodius haemorrhoidalis. Snake Hill; Paterson; under cow manure. Wintersteiner.
Dyscinetus (Chalepus) rubra Web. New Egypt, May 21. *H. B.* Scammell.
Leptura exigua Newm. Hewitt, June 21, on flowers of *Cornus paniculata*. Woodruff. (Jour. N. Y. Ent. Soc., Mar., 1915.)
Eugnamptus collaris Fab. var. *fuscipes* Pierce. Egg Harbor, June 15. H. B. Weiss.
Eugnamptus collaris Fab. var. *nigripes* Melsh. Egg Harbor, June 15. H. B. Weiss.
Phytonomus melus Fabr. The clover weevil. Ramsey, Hewitt, Lake Hopatcong, Newfoundland, Rahway, from late May to end of July. Springfield. E. A. Bischoff.
Magdalis barbicornis Latr. Burlington, May. H. B. Weiss.
Ceutorhynchus affluentus Dietz. This should replace *C. rapæ* Gyll. in the 1909 list as Mr. Dietz states that *C. rapæ* so-called is not the same as the European species of that name. C. A. Frost.
Sphenophorus solitaris. Whitesbog, July 16. H. B. Scammell.
Xyleborus saxeseni. Tuckahoe, October 5, in dead sugar maple. T. J. Headlee.
Hylecoetus lugubris Say. Coytesville, April 18, 1915. R. P. Dow.
Molamba fasciata Say. Tenafly, June 5, in bark of maple tree. H. O. Pond.
Scymnillus aterrimus Horn. Whitesbog. H. B. Scammell.
Zenoa picea Beauv. Red Bank, July 4, 1908. Kaeber. (Ent. News, v. 26, p. 238.)

Order Lepidoptera

Basilarchia archippus var. *lanthanis*, Cook and Watson. Athenia, August 13, 1911. F. E. Watson.

Diacrisia virginica Fab. var. *fumosa* Strecker. Passaic Park, January 20, 1915. Found in house on window. M. H. Mead.

Hyphantria Textor Harris. Passaic Park, June 26. Local, not common. M. H. Mead.

Apantesis intermedia Stretch. Lake Hopatcong, September 15, 1913. F. Lemmer.

Apantesis vittata Fab. form *radians* Wlk. Passaic Park, June 4, 1906. Local, rare, taken at light. M. H. Mead.

Acronycta radcliffei Harv. Orange Mts., May 4, 1913. F. Lemmer.

Acronycta (*Apatela*) *albarufa* Grt. Lakehurst, middle of July. O. Buchholz.

Acronycta (*Apatela*) *brumosa* Gn. Lakehurst, end of May. O. Buchholz.

Acronycta (*Apatela*) *lanceolaria* Grt. Elizabeth, June 22. O. Buchholz.

Apatela (*Acronycta*) *afflicta* Grt. Passaic, Rutherford, July 2. M. H. Mead.

Chytonix sensilis Grt. Cassville, August 17, 1910. W. T. Davis.

Baileya doubledayi Guenee. Passaic, May, June, at light.

Xylophasia nigriar Smith. Passaic Park, July. M. H. Mead.

Hadena misera Grt. Rutherford, August 3, at light. M. H. Mead.

Hadena stipata Morr. Elizabeth, first half of August. O. Buchholz.

Semiphora tenebrifera Wlk. Passaic, April 26. M. H. Mead.

Pachnobia salicarum Walker. Passaic Park, April, 1914. M. H. Mead.

Noctua fennica Tausher. Passaic, July 2, at light. M. H. Mead.

Noctua rubifera Grt. Lakehurst, August and September. O. Buchholz.

Euxoa redimicula Morr. Passaic, July 28, at light. M. H. Mead.

Mamestra assimilis Morr. Rutherford, July at light. M. H. Mead.

Mamestra capsularis Guenee. Passaic, May 27, at light. M. H. Mead.

Leucania (*Heliophila*) *juncicola* Gn. Lakehurst, middle July. O. Buchholz.

Leucania linita Gn. Newark (Ang.); Elizabeth, May, August (Bz); Five-mile Beach, August 12 (Haim).

Leucania scirpicola Gn. Eizabeth, Lakehurst, July, August. O. Buchholz.

Leucania minorata Smith. Passaic Park, May and June. M. H. Mead.

Leucania subpuncta Harvey. Lakehurst, October 9, 1914. Shoemaker and Davis.

Xylina baileyi Grt. Passaic, October 12, at light. M. H. Mead.

Xylina disposita Morr. Passaic Park. M. H. Mead.

Xylina petulca Grt. Rutherford, May 5, 1914. M. H. Mead.

Xylina pexata Grt. Passaic Park, April 17, 1906, Nov., 1911. M. H. Mead.

Nonagria læta Morr. Elizabeth, 1913. F. Lemmer.

Hydroecia stramentosa Guenee. Passaic Park, September 18. At arc light. M. H. Mead.

Papaipema anargyria Dyar. Elizabeth, September 7. Larva in Eupatorium. O. Buchholz.

Papaipema astuta Bird. Union and Essex Counties, September 5 to 22. Larva in horse balm. O. Buchholz.

Papaipema baptisiae Bird. Union and Essex Counties, September 15 to 30. Larva in false indigo. O. Buchholz.

Papaipema cerina Grt. Union County, middle September. Larva in *Lilium candense*. O. Buchholz.

Papaipema duvoata Bird. Larva in *Solidago sempervirens*. Elizabeth, September 14 to 30. O. Buchholz.

Papaipema duplicata Bird. Union and Essex Counties, September 15 to 30. Larva in horse balm. O. Buchholz.

Papaipema eupatorii Lyman. Larva in *Eupatorium purpurea*. Elizabeth, September 20 to 30. O. Buchholz.

Papaipema frigida Sm. Larva in meadow rue. Union County, September 1 to 30. O. Buchholz.

Papaipema harrisii Grt. Record in 1909 list based on misidentification. Does not occur south of Maine. O. Buchholz.

Papaipema impecuniosa Grt. Larva in *Aster puniceus*. Union County, September 15 to 30. O. Buchholz. Passaic Park, September. M. H. Mead.

Papaipema lysimachia Bird. Union County, September 5 to 30. Larva *Lysimachia quadrifolia*. O. Buchholz.

Papaipema maritima Bird. Union County, September 20 to October 10. Larva in *Helianthus giganteus* and *H. tuberosus*. This record should take the place of

necopina in the 1909 list, which was wrongly identified. *Necopina* has never been taken south of Buffalo, N. Y. O. Buchholz.

Papaipema merricata Bird. Elizabeth, September 20. Larva in May apple. O. Buchholz.

Papaipema moeseri Bird. Union County, end September. Larva in *Chelone glabra.* O. Buchholz.

Papaipema necopina Grt. Passaic Park, October. At light. M. H. Mead.

Papaipema pterisii Bird. Larva in *Pteris aquilina.* Union County, August 25 to September 5, O. Buchholz; Passaic Park, September, M. H. Mead.

Papaipema rigida Grt. Union County, September 5 to 30. Larva in *Heliopsis helianthoides.* O. Buchholz.

Papaipema stenocelis Dyar. Lakehurst, September 8 to 25. Larva in *Woodwardia virginica.* O. Buchholz.

Xanthia flavago Fab. Passaic Park, October. M. H. Mead.

Orthosia lutosa Andrews. Passaic, June 30, at light. M. H. Mead.

Parastichtis discivaria Wlk. Passaic, July 31, at light. M. H. Mead.

Scopelasoma ceromatica Grt. Passaic Park, April. M. H. Mead.

Epiglaea apiata Grt. New Egypt. Moths taken on cranberry vines. H. B. Scammell.

Epiglaea pastillicans Morr. Lakehurst, October 17. Buchholz and Lemmer.

Epiglaea tremula Harv. Lakehurst, September 25. O. Buchholz.

Calymnia orina Guenee. Passaic, July 13, at light. M. H. Mead.

Chloridea virescens Fab. Lakehurst, October 11, 1914. E. Shoemaker, W. T. Davis.

Derrima henrietta Grt. Passaic Park, July. M. H. Mead.

Schinia obscurata Strk. Elizabeth, June 5 to 30. O. Buchholz.

Plusia simplex Gn. Whitesbog, Pemberton, moths resting on cranberry vines. H. B. Scammell.

Autographa rogationis Gn. Elizabeth, September 15 to 30. O. Buchholz.

Anomis erosa Hbn. Irvington, November 10, 1912. Bred from larvæ found on hollyhock. (Food plant new record.) F. Lemmer.

Exyra rolandiana Grt. Spring Lake, Toms River, Pleasantville. Larva in Sarracenia. F. M. Jones.

Catocala connubialis Gn. South Elizabeth, July 26, 1912. H. H. Brehme.

Catocala fratercula Grt. var. *jaquenetta* Hy. Edwards. Lakehurst, July. O. Buchholz.

Cotocala epione Dru. Irvington, July 12, 1913. Larvæ on butternut. (Food plant new record.) F. Lemmer.

Catocala innubens Gn. var. *hinda* French. Passaic Park. M. H. Mead.

Anticarsia gemmatilis Hbn. Passaic Park. October 11, 1904. M. H. Mead.

Episeuxis nigellus Strk. Elizabeth, Lakehurst, July. O. Buchholz.

Bomolocha deceptalis Wlk. Passaic, July 26. M. H. Mead.

Melalopha strigosa Grt. Passaic, May 29, at light. M. H. Mead.

Schizura apicalis G. & R. Passaic, May 26, at light. M. H. Mead.

Harpyia scolopendrina Bois. Passaic Park, May 3, 1904. Local, rare, taken at light. M. H. Mead.

Harpyia albicoma Stretch. August 3, 1905, at Passaic Park. M. H. Mead.

Coenocalpe magnoliata Gn. Lake Hopatcong, July 15. Lemmer.

Gypsochroa sitellata Gn. Irvington, August 16, 1913. F. Lemmer.

Erastria includens Wlk. Elizabeth, July 5 to 20. Larva in *Carex stricta.* O. Buchholz.

Eois demissaria Hbn. Lakehurst, May 30 to June 30, O. Buchholz; Elizabeth, Aug. 15, F. Lemmer.

Synchlora liquoraria Gn. Passaic Park, May, June. Common. M. H. Mead.

Anaplodea remotaria Wlk. Union and Passaic Counties, July 20 to August 20. O. Buchholz.

Orthofidonia exornata Wlk. Lyons Farms, April 29, May 2. F. Lemmer.

Apaec tix deductaria Wlk. Eilzabeth, June 7. O. Buchholz.

Cleora indicataria Walk. Orange Mts., July 5, 1913. F. Lemmer.

Cleora tacenaria Pearsall. Lakehurst, July 17. O. Buchholz.

Metrocampa pra grandaria Guenee. Passaic Park, June 24, 1909, August 26, 1910. At light and on tomato vine. M. H. Mead.

Xanthotype crocataria Fabr. var. *celaria* Hulst. Passaic. M. H. Mead.

Plagodis fervidaria H. S. Passaic, April 28, May 3, at light. M. H. Mead.

Plagodis alcodaria Gn. Passaic, May 19, at light. M. H. Mead.

Euchlaena obtusaria Hbn. Lakehurst, May, July, September. O. Buchholz.
Priocycla decoloraria Hulst. Lakehurst, July 3. O. Buchholz.
Sesia rhododendri Beutm. Somerville, August, 1914. Larva in rhododendron stem. H. B. Weiss.
Diathrausta daeckealis Haimbach. Browns Mills Jc., June 22, 1907. E. Daecke. (Ent. News, v. 26, No. 7.)
Pinipestis zimmermanni Grt. Eatontown, August 5. Larvæ in terminal shoots of Austrian and other pines. H. B. Weiss.
Rhyacionia rigidana Fern. Manumuskin. Larvæ taken May 21, 1912. E. Daecke.
Epagoge lycopodiana Kearf. Pemberton, August 25, September 23, October 7, sweeping cranberry bog. H. B. Scammell and H. K. Plank.
Sparganothis violaceana Rob. Pemberton. H. B. Scammell.
Archips georgiana Wlk. Whitesbog. On cranberry and huckleberry. Elizabeth White.
Tortrix bergmanniana Linn. Whitesbog. H. B. Scammell.
Zelleria aimbachi Busck. Wenonah. Bred from short needle pine. F. Haimbach. (Proc. Wash. Soc., June, 1915.)
Gelechia trialbamaculella Cham. Pemberton, among cranberry vines. H. B. Scammell.
Dichomeris vacciniella Busck. Pemberton. Bred from cranberry. H. B. Scammell. (Proc. Wash. Soc., June, 1915.)
Stenoma algidella Wlk. Whitesbog, May 26, 1914. Adult resting on cranberry vine. H. B. Scammell.
Coleophora laricella Hbn. Rutherford, on larch. H. B. Weiss. The larch case bearer.
Coleophora limosipennella Dup. Hackensack, summer of 1914. Case bearer on elm. H. B. Weiss.
Anaphora busckella Haimbach. Jamesburg, July 4. Haimbach. (Ent. News, v. 26, No. 7.)
Anchocelis digitalis Grt. Passaic Park, August, 1913. M. H. Mead.
Callopistra floridensis Guenee. Passaic, 1907. M H. Mead; Riverton, Rutherford, in greenhouses, larvæ doing much damage to ferns, H. B. Weiss.
Cissura spadix Cramer. Passaic, May 6, at light. Probably a visitor. M. H. Mead.
Comala simplex Walk. Passaic Park, July 12, 1906. Taken at light. M. H. Mead.
Dasychira pudibunda Linn. European red-tail. Bergen County. Probably introduced on nursery stock. H. Wormsbacher.
Euharveya carbonaria Harvey. Passaic Park, April 7, 1914. At light. M. H. Mead.
Graphiphora garmani Grt. Passaic, April, 1901 and 1914. M. H. Mead.
Notolphus antiqua Linn. Rutherford, on roses in nursery. H. B. Weiss.
Ochria (Gortyna) buffaloensis Grt. Elizabeth, end of August. O. Buchholz.
Pero marmoratus Grossb. Irvington, August 10. F. Lemmer.
Symmoca novimundi Busck. Montclair. W. D. Kearfott. (Proc. Wash. Soc., June 1915.)
Tornos scolopacinarius Gn. Irvington, August 15, 1914. F. Lemmer.
Xylomiges dolosa Grt. Passaic Park, April 24, 1914. M. H. Mead.

Order HYMENOPTERA

Strongylogaster alboannulatus Rohwer. Brown's Mills Jc. Daecke. (Proc. U. S. Nat. Mus., v. 42, p. 238.)
Pteronus hudsonii Dyar. Rutherford, August 19; Trenton, August 20. Larvæ on poplar. H. B. Weiss.
Kaliosysphinga dohrnii Tischb. Elizabeth, August, 1913 and 1914. H. B. Weiss.
Kaliosysphinga ulmi Lund. Westfield, summer of 1914. Lead miner of elm. H. B. Weiss.
Acordulecera caryæ Rohwer. Fort Lee, larvæ on new shoots of pignut hickory. Dyar. (Proc. U. S. Nat. Mus., v. 43, p. 248.)
Acordulecera parva Rohwer. Fort Lee, September 3, larvæ on young leaves of black oak. Dyar. (Proc. U. S. Nat. Mus., v. 43, p. 248.)
Acordulecera quercus Rohwer. Fort Lee. Larvæ on young leaves of black oak. Dyar. (Proc. U. S. Nat. Mus., v. 43, p. 251.)
Janus abbreviatus Say. Bound Brook, Rutherford, Irvington, Elizabeth, South Orange, Springfield. H. B. Weiss.
Neuroterus saltatorius Hy. Edwards. New Jersey. Galls occur on burr oak, white oak, post oak. W. Beutenmuller.

Callirhytis fruiticola Ashm. New Jersey. Galls in acorns of scarlet, red and black oaks. W. Beutenmuller.

Andricus glandulus Beut. New Jersey. Acorn gall of swamp white oak, chestnut oak, and dwarf chestnut oak. W. Beutenmuller.

Andricus operatola Bassett. New Jersey. Galls on acorns of red, scarlet, black and scrub oaks. W. Beutenmuller.

Andricus perditor Bassett. New Jersey. Gall is deformed acorn of scrub oak. W. Beutenmuller.

Diastrophua fragariæ Bt. Athenia, August. The strawberry leaf petiole gall maker. E. L. Dickerson.

Aulacidea nabali Brodie. New Jersey. Gall at base of stems of *Nabalus altissimi*. W. Beutenmuller.

Rhodites mayeri Schl. New Brunswick, J. B. Smith (Bt.) (Bul. Bklyn, Ent. Soc., Dec., 1914.)

Perilitus epitricis Viereck. Elmer, Robbinsville, Freehold. From middle of July to beginning of September. Also bred from adult *Epitrix cucumeris*. A. E. Cameron.

Apanteles choreuti Vier. Anglesea, July. Reared from *Choreutis carduiella*. Kearfott.

Apanteles epinotiæ Vier. Anglesea, June 15.

Apanteles plesius Vier. Essex Co., June 29.

Apanteles trachynotus Vier. Little Silver, June 20.

Phytodietus vulgaris Cress. New Brunswick. Bred from pupa of *T. politant*.

Coccophagus lumulatus Howard. Bred from a soft scale on Euonymus received from Japan. Elizabeth, April 13, 1911. H. B. Weiss.

Spalangia muscidarum Richardson. Bred from pupae of *Musca domestica* at New Brunswick. C. H. Richardson.

Encyrtus flavus Howard. Bred from *Coccus hesperidum*. H. B. Weiss.

Isosoma orchidearum Westwood. The "cattleya fly." Occurs in greenhouses where Cattleya spp. are grown. H. B. Weiss.

Pheidole anastasii Emery. Rutherford, April 14, 1914. In greenhouses. H. B. Weiss.

Tetramorium guineense Fabr. Rutherford, April 8, 1914. In greenhouses. H. B. Weiss.

Prenolepis fulva Mayr. subsp. *pubens* Forel. Rutherford, April 14, 1914. In greenhouses. H. B. Weiss.

Stigmus conestogorum Roh. New Brunswick, mid-summer. C. H. Richardson.

Aspidiotiphagus citrinus Craw. Bred from *Diaspis carueli* Targ. August, 1913. C. H. Richardson.

Itoplectis conquisitor Say. Brown's Mills, September 24, 1914. Bred from *Peronea minuta* Rob. H. B. Scammell.

Monogonogastra rugator Say. New Brunswick, August 6, 1912. Collected in pupal cell of *Lixus concavus* in *Rumex crispus*. H. B. Weiss.

Monodontomerus dentipes. Parasitic on *Diprion simile* Hartig. Elizabeth, Rutherford, South Orange. H. B. Weiss.

Oxylabis bifoveolatus Brues. Snake Hill. (Can. Ent., April, 1904.)

Signophora nigrita Ashm. Bred from San José scale, October, 1913. H. B. Weiss.

Tenthredella nortoni Smulyan. New Jersey. (Can. Ent., v. 47, p. 321.)

Order Diptera

Boletina obscura Johannsen. Forest Hill, April. Weidt.

Exechia absoluta Johannsen. Riverton. C. W. Johnson.

Exechia attrita Johannsen. Forest Hill, April, November. Weidt.

Exechia canaliculo Johannsen. New Jersey, July.

Exechia captiva Johannsen. Cape May, September. Viereck.

Exechia quadrata Johannsen. Cape May, September, Viereck; Hemlock Falls, August, Weidt.

Mycetophila fastosa Johannsen. Riverton, Delaware Water Gap. C. W. Johnson.

Sciara sciophila Lw. Newark, E. I. Dickerson.

Lasioptera corni Felt. Mountainville, September 24. Dogwood leaf gall. On leaf of *Cornus paniculata*. H. B. Weiss.

Dasyneura parthenocissi Steb. Different parts of State. Midrib gall of Virginia creeper. H. B. Weiss.

Dasyneura trifolii Lw. Newark, September 15. Bred from cocoons on surface of clover leaf. The clover leaf midge. E. L. Dickerson.

Dasyllus champlaini Walton. Brown's Mills Jc., July 10, 1906.

Proctacanthus nigriventris Macquart. New Jersey. H. S. Harbeck. (Ann. Ent. Soc. Amer., v. 4, No. 2.)

Psilopodimus flavipes Ald. Merchantville, July 28. E. W. Stafford.

Psilopodinus viridicoxa Ald. Trenton, June 8, 1911. E. W. Stafford.

Asyndetus harbeckii V. Duzee. Wenonah, June 26. H. S. Harbeck.

Medeterus lobatus V. Duzee. Barnegat City Jc., August 11, 1910. H. S. Harbeck.

Medeterus modestus V. Duzee. Avon, September 27, 1908. H. S. Harbeck.

Hydrophorus indentus Ald. Atlantic City, May 6. Johnson. (Psyche, April, 1911, p. 51.)

Gymnopternus chalcochrus Loew. Wenonah, May 15, 1910. C. T. Greene.

Aphiochæta fisheri Malloch. Delaware Water Gap. C. W. Johnson.

Aphiochæta iroquiana Mall. Pasadena, October 2, 6, 7. Bred from grasshopper. H. K. Plank.

Aphiochæta lutea Meig. Delaware Water Gap, July 12.

Pipunculus aequus Cress. Delaware Water Gap, June and July. C. W. Johnson.

Pipunculus minor Cress. Riverton, C. W. Johnson.

Pipiza albopilosa Will. Palisades, May 10. Osburn. (Jour. N. Y. Ent. Soc., v. 22, p. 336.)

Myiolepta strigilata Loew. Iona, May 17, 1914. H. S. Harbeck.

Syrphus fisheri Walton. Riverton, July 9, 1910. G. M. Greene.

Eristalis arbustorum Linn. Palisade, Lakehurst, Ramsay (R. C. Osburn); Fairlawn, Sewell (E. L. Dickerson). (Jour. N. Y. Ent. Soc., v. 23, p. 142.)

Eristalis latifrons Loew. Snake Hill, July 16, Grossbeck. (Jour. N. Y. Ent. Soc., v. 23, p. 142.)

Zodion intermedium Banks. Malaga, September 15, 1909. C. T. Greene.

Alophora nitida Coq. Pemberton, July 11, 1909. C. T. Greene.

Hypostena tortricis Coq. Cliffwood. Endoparasitic upon larvæ of *Bellura obliqua*. H. H. Brehme.

Chætona nitens Coq. Wenonah, September 5, 1910. C. T. Greene.

Sarcophoga bullata Mans. New Brunswick, May 19, July 18. C. H. Richardson.

Sarcophaga dalmatina Schiner. New Brunswick, August 21. C. H. Richardson.

Sarcophaga falculata Pand. New Brunswick, July 21. C. H. Richardson.

Sarcophaga scoparia Pand. New Brunswick, July 18. C. H. Richardson.

Sarcophaga utilis Ald. New Brunswick, May 25, October 5. C. H. Richardson

Helicobia quadrisetosa Coq. Wenonah, August 21, 1910. C. T. Greene.

Coenosia pallipes Stein. Newark, August 22. E. L. Dickerson.

Scatophaga volucricaput Walk. Newark, July to October. E. L. Dickerson.

Leptocera (Limosina) ferruginata Steub. New Brunswick, July to September. C. H. Richardson.

Leptocera pallipes Johnson. Clementon, May 12, 1899. (Psyche, v. 22, p. 22.)

Lonchæa deutschi Zett. New Brunswick, July 22, August 25. C. H. Richardson.

Sapromyza conjuncta Johnson. Jamesburg, July 4; Avalon, June 8. C. W. Johnson.

Sapromyza disjuncta Johnson. Delaware Water Gap, July 8; Wildwood, August 12.

Agromyza maculosa Mull. Newark, September 1. E. L. Dickerson.

Allodia bulbosa Johannsen. Forest Hill. Weidt.

Allodia falcata Johannsen. Cape May.

Bottcheria atisterna Parker. New Brunswick, September 28. C. H. Richardson.

Coquillettina plankii Walton. Pasadena, August 8. Reared from grasshoppers. H. K. Plank. (Proc. Wash. Ent. Soc., v. 17, p. 104.)

Diachlorus ferrugatus Fabr. Weymouth, July 30, 1904; Stone Harbor, August 9, 1907. Daecke.

Hormomyia cratægifolia Felt. Kingston, August 20. Coxcomb gall on Cratægus leaf. H. B. Weiss.

Hormomyia verruca Walsh. Mountainville, September 24. Gall on willow leaf. H. B. Weiss.

Mycothera impellans Johannsen. Lavallette, May. Viereck.

Neocerata rhodophaga Coq. The rose midge. Found in greenhouses. Maggots in leaf and flower buds of rose. H. B. Weiss.

Neolasiopetera perfoliata Felt. Mountainville, September. Boneset stem gall. H. B. Weiss.

Oecothea fenestralis Fall. Newark, September 18. E. L. Dickerson.

Phytomyza aquilegiae Hardy. Rutherford, Riverton, Elizabeth, New Brunswick. (Inadvertently omitted from the 1909 list.) H. B. Weiss.

Prosimulium hirtipes Fries. New Brunswick, May 10. C. H. Richardson.

Prosimulium mutatum Malloch. Glassboro, March 28, 1910; Clementon, May 7, 1910. C. T. Greene.

Prosimulium notatum Mall. Pemberton, April 22. H. B. Scammell.

Prosimulium pecuarum Riley. Iona, April 21, 1907. C. W. Johnson.

Pseudostenophora bispinosa Malloch. Westville, April 11, 1900.

Ravinia communis Parker. New Brunswick, May 19 to September 26. Also reared from cow and pig dung. C. H. Richardson.

Ravinia latisetosa Parker. New Brunswick, May 19 to August 7. Also reared from cow and pig dung. C. H. Richardson.

Phytophaga violicola Coq. The violet gall midge. Maggots curl leaves. Found in greenhouses. Not common. H. B. Weiss.

Second List

Order Homoptera

Lecanium corni Bouche. Rutherford, Elizabeth, Riverton. On boxwood in nurseries. Not common. Probably introduced from Holland. H. B. Weiss. (Ent. News, v. 26, p. 102.)

Hemichionaspis aspidistrae Sign. In greenhouses on ferns and *Aspidistra*. H. B. Weiss. (Ent. News, v. 26, p. 102.)

Aspidiotus tsugae Marlatt. Rutherford, March, 1914, on Japanese hemlock. Introduced from Japan. H. B. Weiss. (Ent. News, v. 26, p. 102.)

Targionia biformis Ckll. In greenhouses on orchids. H. B. Weiss. (Ent. News, v. 26, p. 102.)

Chionaspis wistariae Cooley. Rutherford on wistaria. Plants originally came from Japan. H. B. Weiss. (Ent. News, v. 27, p. 11.)

Chrysomphalus perseae Comst. In greenhouses on orchids. H. B. Weiss. (Ent. News, v. 27, p. 11.)

Leucaspis bambusae Kuwana. Riverton, March 16, 1911. On bamboo. H. B. Weiss. (Ent. News, v. 27, p. 11.)

Rhopalosiphum ligustri Kalt. Jersey City, July 15, on privet. H. B. Weiss and E. L. Dickerson. (Ent. News, v. 27, p. 163.)

Pseudococcus kraunhiae Kumana. Rutherford, July, 1915, on *Taxus cuspidata*. Evidently introduced from Japan. H. B. Weiss. (Ent. News, v. 27, p. 163.)

Antonina crawi Ckll. On *Bambusa henonis* and *B. aurea*. Riverton, August 6. Evidently introduced from Japan. H. B. Weiss. (Ent. News, v. 27, p. 163.)

Chrysomphalus rossi Mask. On orchids, rubber plants in greenhouses. H. B. Weiss. (Ent. News, v. 27, p. 163.)

Order Hemiptera

Stephanitis pyriodes Scott (*azaleae* Horv.). Rutherford, Arlington, Palmyra, Riverton, Nutley and other parts of the State. August to November. Feeds on foliage of azaleas. Originally imported from Japan. H. B. Weiss and E. L. Dickerson.

Order Orthoptera

Periplaneta australasiae Fabr. South Orange, May 21, 1914. In greenhouses. H. B. Weiss. (Ent. News, v. 27, p. 103.)

Grylloptalpa gryllotalpa Linn. Rutherford, May, June, July, August. Lives in burrows underground and cuts off the roots of various plants. The European mole cricket, introduced from Europe. (N. J. Agr. Exp. Sta. Ann. Rpt. 1915, p. 312.)

Blaberus discoidalis Serv. In New Jersey greenhouses. H. B. Weiss. (Jour. Econ. Ent., v. 10, p. 224.)

Order Coleoptera

Eucactophagus graphipterus Champion. Summit. One specimen only in an orchid house. H. B. Weiss. (N. J. Agr. Exp. Sta. Bul. 296, p. 19.)

Myelophilus piniperda Linn. Rutherford, Sept., 1913. T. J. Headlee. European pine beetle. (N. J. Agr. Exp. Sta. Ann. Rpt. 1913, p. 627.)

Phaedon (*Phlagiodero* Redt.) *versicolora* Laich. Arlington, Elizabeth, August 13, Irvington, July 28. Dickerson and Weiss. Adults and larvæ destructive to the foliage of poplars and willows. This is the common *P. armoricae* of Europe. (Ent. News, v. 27, p. 164.)

Order Lepidoptera

Gracilaria zachrysa Myr. Larvæ on azaleas. In greenhouses in northern New Jersey. Not common. H. B. Weiss. (N. J. Agr. Exp. Sta. Bul. 296, p. 10.)

Evetria buoliana Schiff. Somerville, Rutherford, May 12, 1915. In *Pinus mughus*. H. B. Weiss. The European pine shoot moth. (U. S. Dept. Agr. Bur. Ent. Bul. 170.)

Castnia therapon Koll. In New Jersey greenhouses. H. B. Weiss. (N. J. Agr. Exp. Sta. Bul. 296, p. 19.)

Order Hymenoptera

Diprion simile Hartig. Elizabeth, Rutherford, South Orange. European pine saw fly. H. B. Weiss. (Jour. Econ. Ent., v. 10, p. 224.)

Order Diptera

Merodon equestris Linn. Orange, October 17, 1913. The Narcissus fly. (Ent. News, v. 26, p. 107.)

Phytomyza aquifolii Gour. Rutherford. Leaf miner in English holly. Has also been taken on holly imported from Holland. H. B. Weiss. (Ent. News, v. 27, p. 13.)

Monarthropalpus buxi Lab. Rumson, Peapack, July, 1914. Boxwood leaf miner. (N. J. Agr. Exp. Sta. Ann. Rpt. 1916, p. —.)

Parallelodiplosis cattleya Moll. In New Jersey greenhouses. H. B. Weiss. (N. J. Agr. Exp. Sta. Bul. 296, p. 19.)

V

INVESTIGATIONS

Influence of Atmospheric Moisture on Insect Metabolism

Under this head attention has been given to the influence of atmospheric moisture on the speed of insect metabolism; the bean weevil (*Bruchus obtectus* Say) was used as the principal species for experiment but the angoumois grain moth (*Sitotroga cerealella* Oliv.) and the Indian meal moth (*Plodia interpunctella* Hbn.) also were tried.

In summing up the status of knowledge regarding the influence of atmospheric moisture upon insect metabolism, Bachmetjew[1] said in substance that there is an optimun degree of atmospheric moisture for the development of insects but that degree is not the same for all species. Atmospheric moisture operates both directly and indirectly upon insects—directly by reducing the body fluids and indirectly by encouraging fungous diseases both by supplying the atmospheric conditions for growth of the fungus and by weakening the insect through affecting its food in such a manner as to render it especially susceptible to disease.

The nine years that have passed since the publication of Bachmetjew's

[1] Bachmetjew, " Experimentelle Entomologische studien, Einfluss der Ausseren Faktoren Auf Insekton. Bd 2, pp. 689–690.

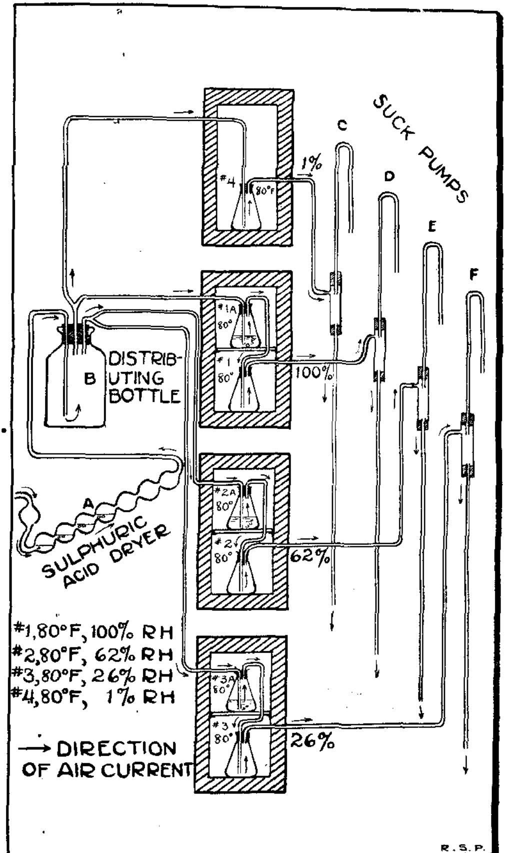


Fig. 1.—Diagram of apparatus used in the study of the effect of atmospheric moisture.

summary seem not materially to have changed his conclusions. A few studies have been made but the prime need is still the derivation of facts. With this in mind the writer set out to determine the response of metabolism of one or more insects to atmospheric moisture. The rate of metabolism was chosen as the principal measuring stick of the response.

Four constant-temperature chambers were chosen and the glass containers in each were placed in such a fashion that through each set one liter of air from out-doors was drawn every 12 minutes. In some instances the speed of air was much greater but in few if any cases was the change less rapid. The air currents in all chambers had the same temperature but that in each had a different degree of atmospheric moisture.

In order to obtain perfectly fresh material it was necessary to cause the insect-infested seed and grain to develop the adults of the species concerned. Advantage was taken of this fact to accumulate data on the influence of atmospheric moisture on emergence. Approximately equal numbers of infested beans were placed in each of four flasks and the same disposition was made of infested corn. One bean and one corn flask was placed in each chamber and subjected 80° F. and different degrees of moisture The results appear in Table I.

Table I

Influence of Atmospheric Moisture on Emergence of the Angoumois Moth and the Bean Weevil

CHAMBER	Temperature F.	Atmospheric Moisture, Per Cent.	Date of Beginning	EMERGENCE: No. of Days in Period	EMERGENCE: No. of Days to Maximum	EMERGENCE: No. of Specimens	DEATH: Date of Beginning	DEATH: No. of Days in Period	DEATH: No. of Days to Maximum
ANGOUMOIS GRAIN MOTH									
No. 1.	80°	100	1/17	17	9	20	1/21	18	8
No. 2.	80°	72.6	1/17	17	7	8	1/21	16	7
No. 3.	80°	44.7	1/16	16	11	8	1/22	15	8
No. 4.	80°	21.8	1/15	12	6	16	1/21	15	6
BEAN WEEVIL									
No. 1.	80°	100	1/16	22	5	32	1/20	17	8
No. 2.	80°	71.5	1/16	21	6	27	1/21	16	7
No. 3.	80°	44.6	1/15	14	4	39	1/17	10	12
No. 4.	80°	21.5	1/15	15	7	31	1/16	18	12

In dealing with emergence, decrease in atmospheric moisture appears to hasten the emergence and to decrease the period occupied by it. It appears also to shorten the period from beginning to maximum emergence. In dealing with death, decrease in atmospheric moisture appears to hasten the beginning of death, and to shorten both the period and time to maximum death in the moth but to lengthen both for the beetle.

With fresh material in hand the main study was started. The bean weevil has been the only species that we have succeeded in breeding in an entirely satisfactory way. Table II sets forth the results of the study. (Plate I.)

Table II

Influence of Atmospheric Moisture on Three Broods of the Bean Weevil

CHAMBER	Temperature F.	Moisture, Per Cent	Date When Majority of 1st Brood Is Dead	Date When Majority of 2d Brood Have Emerged	No. of Days Involved	No. of Specimens At Beginning	No. of Specimens At End	Period of Emergence Beginning	Period of Emergence End	Period of Emergence No. of Days
				FIRST BROOD						
No. 1, ...	80°	100	2/5	2/25	20	25	150	2/21	3/4	12
No. 2, ...	80°	69.3	2/4	2/27	23	25	129	2/23	3/3	8
No. 3, ...	80°	44.1	2/2	2/29	27	25	11	2/25	3/1	5
No. 4, ...	80°	20.5	1/31	*	....	25	00	....	....	....
				SECOND BROOD						
No. 1, ...	80°	100	†2/25	4/3	38	131	491	....	....	....
No. 2, ...	80°	59.4	†2/27	4/6	39	120	27	....	....	....
No. 3, ...	80°	39.9	†2/29	4/10	41	15	14	....	....	....
No. 4, ...	80°	23.6	....	....	....	....	....	....	....	....
				THIRD BROOD						
No. 1, ...	80°	100	9/3	‡	‡	25	00	....	....	....
No. 2, ...	80°	62	9/3	10/4	31	25	101	....	....	....
No. 3, ...	80°	26	9/2	§	....	25	00	....	....	....
No. 4, ...	80°	1	9/1	§	....	25	00	....	....	....

* Not at all.
† Date of maximum emergence.
‡ Fungi destroyed both beetles and beans.
§ Nothing emerged.

It thus appears: (1) that the rate of metabolism as measured by the *length of life cycle varies as the atmospheric moisture; (2) that reproductive* ability varies as the atmospheric moisture, and that relative humidity of 26 per cent. or less effectually prevents reproduction of the species; (3) that while 100 per cent is the optimum of atmospheric moisture for the beetle's activity it promotes the growth of destructive fungi to such an extent that the optimum must be placed between 75 per cent and 100 per cent at the point where the fungi are unable to develop.

Further data on the effect of low atmospheric moisture on the development of progeny came from a set of experiments which was devised for the purpose of determining whether concentrated sulphuric acid, which we wished to use in drying the air, gave off any matter injurious to the adult bean weevil. Five glass museum jars each with a capacity of 1,000 c.c were selected. In the first, 250 c.c. of concentrated acid was placed; in the second, a mixture of 125 c.c. of water and 125 c.c. of acid; into the third, a mixture of 83 c.c. of acid and 167 c.c. of water; in the fourth, 250 c.c. of distilled water, and in the fifth no liquid whatever. Into each of five 2-ounce wide-mouthed bottles enough beans were introduced to cover the bottom.

25 vigorous beetles were added and the opening covered with gauze. Each bottle was suspended by a short piece of wire into the inside of the jar cover. The lids were put into places and screwed down on the rubber contact band.

In a little over one month the beans over air only produced a new brood of beetles. The beans over distilled water were destroyed by fungi and no beetles were produced. The beans over the mixture composed of about $\frac{1}{3}$ acid and $\frac{2}{3}$ water produced a small brood. The beans over the half-and-half mixture of acid and water and those over the concentrated acid showed no injury whatever.

Studies intended to develop whatever may be practicable in the way of storing seeds and grain in an atmospheric moisture so small as to render them free from insect injury are now under way but have not yet reached a point where they can be satisfactorily reported.

The Strawberry Weevil

The study of this insect last year brought out the remarkable efficiency of the mixtures of powdered arsenate of lead and sulfur in protecting the strawberry from its ravages. Two applications—the first just as the bud-cutting began and the second about one week later, gave almost perfect protection with the half-and-half mixture and only a little less complete results with the mixture composed of 1 part of lead arsenate to 5 parts of sulfur.

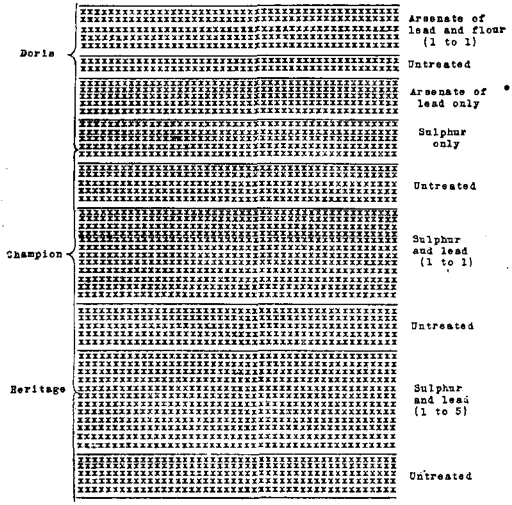
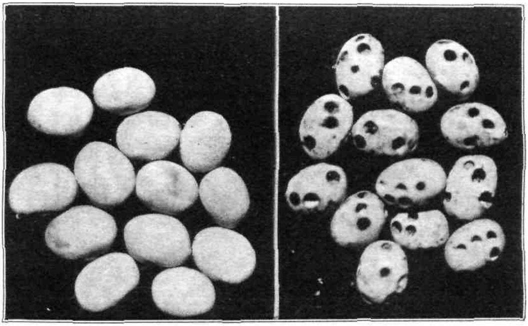


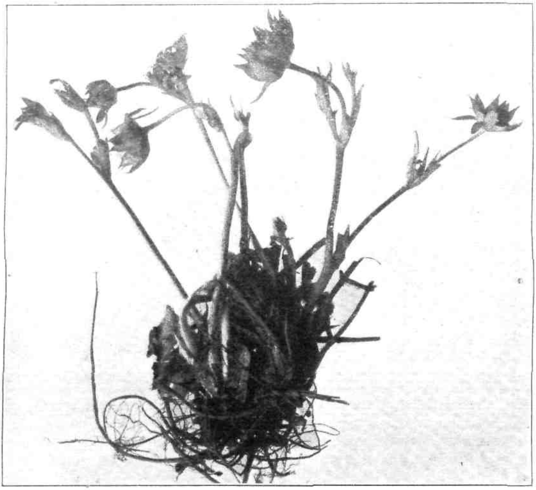
Fig. 2.—Diagram of strawberry plots on Mr. Oeser's farm near Cologne: xxxxx = rows

PLATE I.



Photograph showing the protection afforded beans in storage by being kept in a dry atmosphere: left—under dry atmosphere; right—under a moist atmosphere.

PLATE II.



Reduction in crop possibilities by the strawberry weevil; 10 buds out of 14 destroyed.

Table III

Results of Experiment on Control of the Strawberry Weevil on the Farm of William Oeser, Cologne, N. J.

Treatment		Variety	Percentage of Buds			Comparative Yield Per Acre, qts.	Increase Due to Treatment, qts.	Value	Estimated Cost of Treatment	Net Return
Nature	Time		Clean	Stung	Cut					
Untreated		Heritage	17.7	31.5	50.7	442				
Arsenate of lead 1 part + sulfur 5 parts	5/6, 5/12, 5/19	Heritage and Champion	62.7	19.2	18.1	2,442	1,610.5	$128.84	$16.00	
Untreated		Champion	52.7	20.5	26.7	1,221				
Arsenate of lead 1 part + sulfur 1 part	5/6, 5/12, 5/19	Champion	78.0	12.2	9.8	2,604	1,532.	$122.56	$24.00	$98.56
Untreated		Champion	56.7	14.5	28.8	903				
Sulfur	5/6, 5/12, 5/19	Champion and Doris	58.5	14.7	26.8	1,313	481.5	$38.52		$112.84
Arsenate of lead	5/6, 5/12, 5/19	Doris	71.2	15.8	13.0	1,106	343.	$27.44		
Untreated		Doris	57.5	15.5	27.0	700				

This year the successful mixtures were given a trial on a field scale in three different counties. In Atlantic the most careful study was made again on the farm of Mr. Wm. Oeser, of Cologne, in close coöperation with Mr. Ellwood Douglass, the farm demonstrator of that county. In addition to the work on Mr. Oeser's place, Mr. Douglass observed the results on 17 other places in Atlantic County and reports similar results obtained everywhere. Mr. Warren Oley, farm demonstrator for Cumberland, tried the mixtures on four places. Mr. George T. Reid, farm demonstrator for Burlington, applied the treatment in three different places.

Table III shows the results on Mr. Oeser's place. The area treated here totalled 2½ acres. The results are, however, figured on an acre basis for the sake of making the comparisons more easily comprehended.

Table IV

Results of Experiment on Control of the Strawberry Weevil on the Farm of Richard Smith, Leesburg, N. J.

Variety	Treatment	Per Cent of Buds Cut on June 6	Increased Yield Over Check, Stated in Per Cent
Darlington, Old Bed	None	47.6	
Darlington, Old Bed	Powdered Lead Arsenate (1 lb.) + Sulfur (1 lb.)	16.0	50
Gandy, Old Bed	None	17.3	
Gandy, Old Bed	Powdered Lead Arsenate (1 Part) + Sulfur (1 Part)	6.5	25
Gandy, Old Bed	Powdered Lead Arsenate (1 Part) + Sulfur (5 Parts)	4.2	Perceptible
Darlington New Bed,	None	42.5	
Darlington New Bed	Powdered Lead Arsenate (1 Part) + Sulfur (5 Parts)	18.2	30
Shropshire	None	18.7	
Shropshire	Powdered Lead Arsenate (1 Part) + Sulfur (5 Parts)	10.8	30 to 35

In Cumberland County on the farm of Mr. Richard Smith, near Leesburg, the most carefully conducted tests took place. Here the plots were laid out in two fields by the writer and the treatments were made by Mr. Oley. The larger of the two fields consisted of old beds and covered about 2.6 acres, while the smaller was made up of new beds and occupied about

Table V

Results of Experiments on Control of the Strawberry Weevil on Farms at Marlton and Moorestown, N. J.

Place	Owner	Variety	Treatment	Percentage of Buds Cut by June 5
Marlton	Chas. Dey	Unknown Old Bed	None	25.2
			Powdered Lead Arsenate (1 part) + Sulfur (5 Parts)	10.7
		Heritage, Old Bed	None	20.8
			Powdered Lead Arsenate (1 part) + Sulfur (1 Part)	13.6
		Unknown, New Bed	None	58.2
			Powdered Lead Arsenate (1 part) + Sulfur (5 Parts)	22.2
Marlton	H. J. Alt	Wm. Ball	None	48.0
			Powdered Lead Arsenate (1 part) + Sulfur (5 Parts)	10.1
			None	25.5
			Powdered Lead Arsenate (1 part) + Sulfur (1 Part)	13.4
Moorestown	Ellis Rudderow	Success with a Pistilate Variety, 1 Row Staminate to 4 Rows Pistilate	None	29.7
			Powdered Lead Arsenate (1 part) + Sulfur (5 Parts)	8.8

0.8 acre. The statements of yield have been furnished by Mr. Smith and were not verified by either Mr. Oley or the writer. The determination of the percentage of buds cut was made by Mr. Chas. H. Richardson.

In Burlington County Mr. Reid made the applications himself. Mr. Chas. H. Richardson made a count of the buds cut on each of the plots under treatment.

The increase in cutting which followed the application of the sulfur-lead dusts last year was almost negligible. This year the treatments began at a time when very little cutting had occurred, and in every case showed considerable increase. The applications this year were not made with quite the same completeness as those of last year, largely owing to an effort to carry out the test under commercial conditions. The consequently less complete coating is probably to be blamed for the increased cutting. This merely means that better results from the standpoint of reduced cutting than those listed above may be had by more careful work.

The machine used in making all the treatments, which is a one-man dust gun made by the Tow-Lemons Mfg. Co., while more satisfactory for this work than the Leggett gun of a similar type, is very unsatisfactory both from the standpoint of effecting a good coating in a limited time and from the standpoint of the operator's comfort. It will answer for small patches, but a traction or power machine must be had for fields.

The better results obtained on the farm of Mr. Oeser are probably due to the fact that his plots had one more dusting than any other, and by the further fact that the materials were there applied by persons who had the greater experience.

Summarizing the results of the tests we may say that the application of a mixture of powdered lead arsenate and sulfur reduced the bud cutting from 50 to 75 per cent and increased the yield from 25 to 200 per cent, that this meant on the Oeser farm a net return at the rate of more than $100 an acre, that the mixture composed of 1 part of lead arsenate and 5 parts of sulfur is almost, if not quite, as effective as the one composed of 1 part of lead arsenate to 1 part of sulfur, that an efficient traction or power duster is needed, and that more efficient distribution of the mixture will be followed by still better results (p. 491).

Apple Plant Lice

Apple plant lice did so much harm in the season of 1915 that it seemed something must be done to prevent their ravages. For the first time in many years they did not yield to the ordinarily recommended treatments. For several years previous to 1915 the growers in New York State had been feeling the inadequacy of the usual methods. A study of the species concerned in the New Jersey injury revealed the fact that the rosy aphis (*Aphis sorbi* Kalt.) was almost exclusively to blame for the trouble. Previous to 1915 this species had not been numerous enough in the State to attract attention. The fact that its appearance in large numbers is coincident with the failure of the common methods of control leads one naturally to think that it is a more difficult species to destroy. At any

rate the measures that had answered for *Aphis pomi* Fabr. for years absolutely failed to control *Aphis sorbi* Kalt. satisfactorily.

When the 1915 outbreak had gotten well started Mr. John H. Barclay, of Cranbury, brought some badly curled leaves to the office, and the writer set a test to see what strength of nicotine was necessary to effect prompt destruction of the pest. The under sides of the leaves were covered with *A. sorbi* in all stages of development. The writer applied the mixture with a strong atomizer, holding the curled leaves open, and continuing the treatment until the under side of each of the leaves was drenched. Each group of treated leaves, which had at least 200 lice on them, was then placed on heavy paper at the center of a ring of tanglefoot ranging from 6 to 8 inches in diameter. The treatments were made during the afternoon and the results taken the following forenoon.

Table VI

Results of Laboratory Experiment on Control of Apple Plant Lice

Number of Leaves	Treatment	Percentage Living at End of Experiment
2	Water only	100
2	Black leaf 40 (1 part) + water (900 parts)	60
2	Black leaf 40 (1 part) + water (900 parts) + soap (2 lbs. to 50 gal.)	10
2	Black leaf 40 (1 part) + water (700 parts) + soap (2 lbs. to 50 gal.)	1
2	Black leaf 40 (1 part) + water (500 parts)	10
2	Black leaf 40 (1 part) + water (500 parts) + soap (2 lbs. to 50 gal.)	0

Thus it became clear that any strength less than 1 to 500 had an element of risk in it. An actual orchard test put on soon after these laboratory results had been obtained showed that while all lice which were hit with the mixture, composed of 1 part of "black-leaf 40" to 500 parts of water and soap at the rate of 2 pounds to 50 gallons, were promptly killed, such a large proportion were protected from the spray by the curled leaves that the control of the species even by this strength was impracticable.

The lice cost Mr. Barclay not less than a thousand dollars. In the fore part of June they left the orchard and did not return until early November. They came back in sufficient numbers to deposit an enormous supply of

eggs. Mr. Barclay was thus made to realize that the task of protecting his crop in 1916 was certainly not any less and perhaps much greater than it was in 1915. Accordingly a very close watch of conditions was instituted and preparations were made for treating the orchard with lime-sulfur (1 to 9) + "black-leaf 40" (1 to 1,000) when the buds showed green.

The close watch was kept to determine just when the lice hatched, for the 1915 experience had caused both Mr. Barclay and the writer to suspect that the period between hatching and the stage when the buds were opened sufficiently not only to permit burning but to afford protection to the lice, was too short to permit adequate treatment of the orchard. As a matter of fact, the aphis began hatching in considerable numbers on the afternoon of Saturday, April 15, and by noon on the following day nearly every flower bud of the unsprayed trees had a half-dozen or more aphis. The trees which had received either lime-sulfur or scalecide during dormancy showed rarely more than one specimen per bud and many of the buds were absolutely free from infestation. At this time the most advanced flower buds showed the first green leaves separating from the cluster.

On April 18 the writer again visited the Barclay orchard and went over it in a detailed manner. The buds were now well opened and the leaves separated from the flower cluster although the flower buds still adhered to each other. Under these conditions the lime-sulfur at winter strength would not only burn the tips of the leaves but, what is still more serious, the lice could obtain shelter from the spray. Furthermore, two days are insufficient to allow for spraying an orchard under spring conditions. The minimum time for the Barclay orchard is 5 days and with the not unusual spells of bad weather a week would be required. It thus seems clear that there exists an element of risk in attempting to control aphis with the delayed winter-strength lime-sulfur.

The 1915 experience with the inadequacy of the formerly effective measures led the writer to plan a set of tests, the nature and results of which will now be recorded. The scene of the experiments was the young apple orchard of Mr. John Barclay. Mr. Barclay made the applications planned, *in his characteristically thorough manner, and the results obtained are* largely due to his excellent and valuable coöperation.

The plots were arranged as shown in the diagram on page 497.

The nature and the results of the treatments are set forth in Table VII.

When we remember that unsprayed trees showed an average of 6 aphis per fruit bud, the preceding table makes it very clear that each treatment applied reduced the pest materially.

Scalecide of winter strength applied just as the buds began to show green seemed effective, but, unfortunately, killed fully 50 per cent of the fruit buds. Observation outside the experimental plots as well as direct records in the above table showed clearly that lime-sulphur of winter strength applied in the green bud stage would not effect a control.

Plot 2 when compared with Plots 4 and 5 shows that the winter application of lime-sulfur when followed by treatment at the green bud stage is not important.

Comparison of the results on Plot 1 with those on Plot 2 shows clearly that the "black-leaf 40" plus soap is more effective than the combination of "black-leaf 40" and lime-sulfur.

Plan for Aphis Experiment in the Apple Orchard of Mr. John Barclay, near Cranbury, N. J.

No. 1				No. 2				No. 3				No. 4				North No. 5				No. 6		No. 7		
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Fall Pippin ½ Greening ½
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Duchess
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Grimes
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	McIntosh Red
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	McIntosh Red
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Rome Beauty
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	*McIntosh Red*
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Twenty Ounce
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Stayman Winesap
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Twenty Ounce
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Jonathan
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Duchess
																South								
Lime-sulfur (1 to 9) during dormancy; black leaf 40 (1 to 1,000) + soap (2 lbs. to 50 gal.) when buds show green.				Lime-sulfur (1 to 9) during dormancy; lime-sulfur (1 to 9) + black-leaf 40 (1 to 1,000) when *buds show green.*				Lime-sulfur (1 to 9) when the buds show green.				Lime-sulfur (1 to 9) + black-leaf 40 (1 to 500) when *buds show* green.				Lime-sulfur (1 to 9) + black-leaf 40 (1 to 1,000) *when* buds show green.				Scaleside during dormancy.		Scaleside when buds show green.		

Table VII

Results of Orchard Experiment on Apple Plant Lice

Plot No.	Treatment	Determination of Infestation, 4/20/1916 Stayman Winesap		Determination of Infestation, 4/28/1916 Twenty Ounce		Remarks
		No. of Buds	No. of Lice	No. of Buds	No. of Lice	
1	Lime-sulfur (1 to 9) during dormancy; black leaf 40 to 1,000) + soap (2 lbs. to 50 gal.) when buds show green	53	4	60	0	No injury
2	Lime-sulfur (1 to 9) during dormancy; lime sulfur (1 to 9) + black leaf 40 (1 to 1,000) when buds show green	57	6	60	1	No injury
3	Lime-sulfur (1 to 9) when the buds show green	54	38	80	8	No injury
4	Lime-sulfur (1 to 9) + black leaf 40 (1 to 500) when buds show green	101	6	60	0	No injury
5	Lime-sulfur (1 to 9) + black leaf 40 (1 to 1,000) when the buds show green	100	53	60	7	No injury
6	Scalecide (1 to 15) while the buds were dormant	75	14	60	2	Badly Scorched
7	Scalecide (1 to 15) when the buds show green	76	5	60	0	Badly Scorched; 50 per cent killed

Table VII—Continued

Results of Orchard Experiment on Apple Plant Lice

Plot No.	Treatment	Determination of Infestation, 4/20/1916 Grimes Golden		Determination of Infestation, 4/28/1916 McIntosh Red		Remarks
		No. of Buds	No. of Lice	No. of Buds	No. of Lice	
1	Lime-sulfur (1 to 9) during dormancy; black leaf 40 (1 to 1,000) + soap (2 lbs. to 50 gal.) when the buds show green	68	1	100	0	No injury
2	Lime-sulfur (1 to 9) during dormancy, followed by lime-sulfur (1 to 9) + black leaf (1 to 1,000) when buds show green	65	4	100	7	No injury
3	Lime-sulfur (1 to 9) when buds show green	86	88	100	150	No injury
4	Lime-sulfur (1 to 9) + black leaf 40 (1 to 500) when the buds show green.	78	5	100	0	No injury
5	Lime-sulfur (1 to 9) + black leaf 40 (1 to 1,000) when the buds show green.	71	87	100	9	No injury
6	Scalecide (1 to 15) during dormancy.	71	8	100	15	Badly Scorched
7	Scalecide (1 to 15) when the buds show green.	67	3	100	1	Badly Scorched; 50 per cent killed

Comparison of the results on Plot 4 with those on 5 clearly shows that lime-sulfur of winter strength plus "black-leaf 40" (1 to 500) is decidedly more effective than lime-sulfur of winter strength plus "black-leaf 40" (1 to 1,000).

The plot which had been treated with lime-sulfur (1 to 9) at the green bud stage showed such an infestation of aphis on April 20 that the writer felt that something must be done to prevent later damage. This afforded an opportunity for testing the effectiveness of "black-leaf 40" at lower strength than 1 to 500 and accordingly two of the four rows were thoroughly sprayed with "black-leaf 40" (1 to 800) plus soap (2 lbs. to 50 gal.). The following day the writer visited the orchard and examined the treatment. The counts recorded were made on McIntosh and the cluster buds had separated but the bloom was not yet open.

Thirty-eight fruit buds on the treated trees showed 8 lice and 36 fruit buds on the untreated trees showed 20 lice. The results of the counts were checked by a great number of random examinations and the writer believes that they fairly represent the conditions. All four rows were then sprayed with "black-leaf 40" (1 to 500) plus soap (2 lbs. to 50 gal.) and the infestation wiped out.

Summarizing this work we may say that the results of these experiments indicate that rosy aphis can best be destroyed by making a dormant treatment with lime-sulfur or scalecide and following that with a green-bud treatment of "black-leaf 40" (1 to 1,000) plus soap (2 lbs. to 50 gal.), or by delaying the dormant treatment of lime-sulfur until the buds begin to show green and then applying it mixed with "black-leaf 40" (1 to 500).

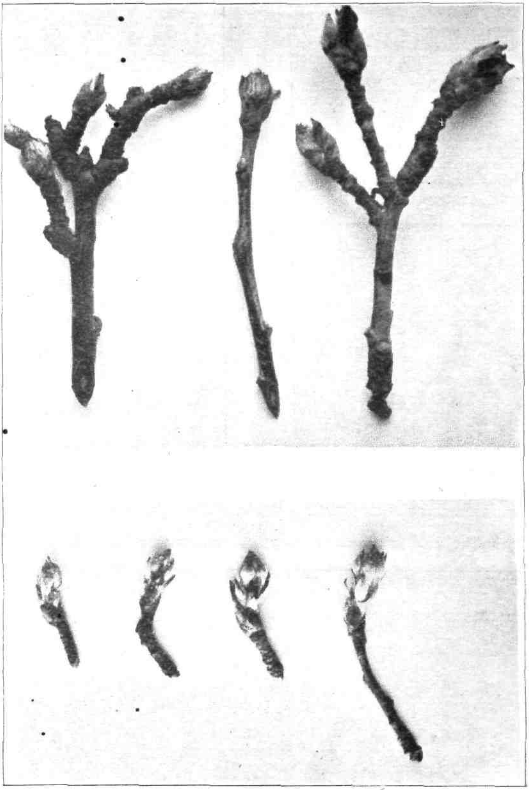
The writer realizes that this conclusion does not coincide with the results of rosy aphis control as set forth by the Geneva, N. Y., Experiment Station. It is, furthermore, his experience that a treatment with winter-strength lime-sulfur plus "black-leaf 40" (1 to 1,000), in the J. L. Lippincott orchard at Riverton, gave this past season an entirely satisfactory control.

The factor which causes this disagreement is in all probability the natural control effected by the weather or natural enemies or both. If the weather should promptly become warm and stay warm and thus encourage the ever ready natural enemies of the rosy aphis or should become for a brief period cold enough to destroy them, the application of a relatively ineffective treatment would give entirely satisfactory control, for the few that the treatment left would be promptly destroyed by natural forces. So far as the writer knows, no one has determined just what percentage of kill constitutes satisfactory control under the varied conditions of weather and natural enemies.

In view of this uncertainty as to just what percentage of the total number of lice must be destroyed in order to effect satisfactory control it would seem that the treatment which destroys the largest percentage should be the one adopted.

The time of application is a matter which depends on aphis and bud development. Application must be made after the lice hatch from the eggs or the material and labor is largely wasted. It seems that it should be easy to tell when the bud first shows green, but, as a matter of fact, the bud exhibits in the course of its unfolding several shades of green. In A.

A B C



D E F G

Photograph of the opening buds to illustrate proper time for spraying. Perfectly safe until fourth stage (D) is reached.

the bud scales have separated and the light green tips are projecting. The lightness of the green is due to the felt-like covering and silvery hairs on the under sides of the leaves. In B, the green becomes a little darker but the silvery shade is still very prominent. In C, some of the leaves have begun to project from the buds like the ears of a squirrel. The inside of these projecting leaves is characteristically green while their outsides still have the silvery shade. The development of D is about that of C. By the time the stage illustrated by E is reached the lice can find some protection and by the time the condition illustrated by G is reached a considerable percentage of the lice have safe shelter and the lime-sulfur is likely to do harm.

The buds show green from the stage illustrated by A to G.

The False Cabbage Aphis

This season is the first during which the false cabbage aphis (*Aphis Pseudobrassicæ* Davis) has been taken in New Jersey, but the experience of the past four years about Freehold and some years ago in Long Island leads one to think that the species has been present for a considerable period and has been during that time confused with other species.

In Bulletin 185 of the Indiana Agricultural Experiment Station, Mr. John J. Davis records an extensive study of the species in the course of which he concludes that the insect may occur wherever the wild mustard grows and that it may be destructively abundant where turnips and radishes are planted. He further records that it is usually seriously injurious only in the fall. Mr. Davis was unable to find that it produces a migrating generation at any time of the year and he was unable to produce the sexed individuals. It would therefore seem likely that the species lives throughout the year on the wild mustard and that it passes the winter in the egg stage. In addition to its importance as a field pest of turnips and radishes he holds that it is likely to prove a greenhouse pest of importance.

Mr. Davis' breeding experiments of the false cabbage louse show that the insect under outdoor conditions produced a maximum of 25 generations and a minimum of 11. The average number of young is shown to be 99 individuals. This makes this species the most prolific of all plant louse species that have been studied.

Mr. Davis recommends spraying with a mixture of 40 per cent nicotine (1 to 1,200) + soap (4 lbs. to 50 gal.). He further recommends the keeping down of all weeds of the cabbage family such as black mustard, pepper grass, and shepherd's purse by clean cultivation, rotation of crops, and fall plowing or spading of the turnip fields. In greehouses he recommends the application of the spray mentioned or fumigation with hydrocynic acid gas.

During the present fall the entomologist's attention was directed to measures of control by the occurrence of heavy infestation in turnip fields in the vicinity of Freehold. He first tested an orchard sprayer, but found that the amount of material used (about 1,500 gal.) per acre was prohibitive. He then devised an apparatus which could be attached to a traction

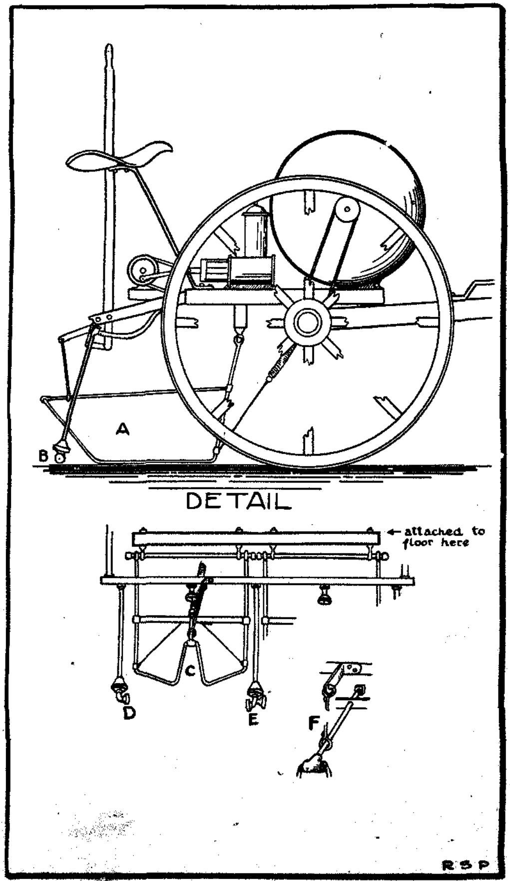


Fig. 3.—Diagram of the spraying machine used against the false cabbage aphis: A = side view of lifter; B = soil; C = space through which plants pass; D & E = nozzles; F = arrangement for lifting the lifter at end of row when machine is turning.

sprayer for lifting the foliage in such a manner as to expose the under side of the turnip leaves to the mist delivered by the low hung nozzles of a potato machine. Success with this sort of apparatus demands the maintenance of high pressure. The nature of this apparatus and its method of use on a sprayer is illustrated in figure 3.

Pear Psylla

In the annual report for last year (1915) the entomologist gave the following procedure as the one likely to give satisfactory control:

1. The rough bark should be scraped off during the fall and winter, care being taken not to injure the live tissue. The scrapings should be gathered and burned, in order that all hibernating psylla sheltering in them may be destroyed.

2. During warm days in late fall and early winter or late winter and early spring, preferably after the scraping has been completed, when the psylla are *crawling* over the bark, the trees should be thoroughly sprayed with winter-strength soluble oil or with 40 per cent nicotine (1 to 800) + soap (1 oz. to the gal.). The spray must not freeze on the tree.

3. *Just before the blossom buds open and after the eggs are laid*, spray thoroughly with lime-sulfur (1 to 9).

The first treatment is intended to deprive the psylla of the cover which protects it both from storms and spraying mixtures. The second is planned to destroy the adults after they have been induced by the warmth to come out of their hiding places and move about over the bark. The third is intended to destroy the eggs.

During the past season the J. L. Lippincott Co., of Riverton, N. J., tried this plan in their Kieffer orchard. One block was given the third treatment and the rest of the orchard received all three.

When examined in the fall considerable numbers of maturing and matured psylla could be found throughout the orchard. The fruit had been picked when the entomologist arrived, but was reported by Mr. Lewis as being absolutely free from staining. The block which had been given the one treatment only showed considerable staining on the fruit spurs and the under sides of the leaves, while the rest of the orchard, which had received the three treatments, showed no staining on the fruit spurs and very little on the under sides of the leaves.

The Kieffer pear orchard belonging to Mr. Lester Collins, of Moorestown, was examined the same day. This orchard was 35 or more years old, had not been scraped or winter-treated, but had received a treatment with lime-sulfur (1 to 9) just before the flower buds opened. The amuont of staining here on the fruit spurs and leaves was very considerable and the fruit exhibited some injury.

In the winter and spring of 1915 Mr. J. S. Richdale, of Phalanx, New Jersey, attempted to control of psylla in his Kieffer pear orchard. To the older and better grown part of the orchard he applied the three treatments outlined at the beginning of this article, except that instead of burning the scrapings he plowed them under deeply. To the portion he applied

the lime-sulfur just before the blossoms opened. The entomologist examined his orchard about two weeks later and was unable to find any psylla at all in the former portion, but found it abundantly in the latter. A further examination in the fall of 1916 failed to show any psylla in the part, which had received the three treatments in 1915, although that block had been treated with summer-strength lime-sulfur and arsenate of lead only.

It thus seems that the adoption and carrying out of the three treatments are necessary in an orchard where the psylla has been unchecked for a number of years. Of course, we have in the last two years no direct experiments to show that the scraping is worth while, but it stands to reason that the rough bark of a Kieffer pear should prove a hindrance to reaching the psylla with spraying materials.

Wintering Bees

Enough has been written on this subject to fill a book, but there seems, nevertheless, still to be room for definite and accurate data. For many reasons it is desirable to winter bees out-of-doors and the questions of whether cover is worth while and what sort of cover is efficient are ones upon which accumulations of facts are needed. In the season of 1914-1915 the opportunity to contribute to this matter came along and a set of experiments was planned by the entomologist and Mr. E. G. Carr and carried out by the latter.

In the fall the colonies, which were in 8-frame hives, were equalized as regards size and winter stores. Three groups were made. The first, consisting of 9 colonies, were left totally without packing. The second, consisting of 9 colonies, were protected with the C. H. Root cover. The third, consisting of 12 colonies, was packed in 3 quadruple covers.

The C. H. Root case consists of three parts—the bottom, the body and the cover. The first is 16 inches wide, 4 inches deep and 22 inches at the top and 28 at the bottom. The slant is covered and acts as an alighting board. This box base has a bottom but no top and is packed with leaves. Along each side and across the back, about 1 inch below the upper edges, is nailed a ⅞-inch strip. The body is a double-walled box just large enough inside to fit over the hive body minus its hand-hole cleats and regular cover, and the double walls inclose a space between them of 2 inches, which is packed with ground cork. The cover is simply a shallow box of the proper size to fit closely over the body in a telescoping manner, and is covered with good roofing paper. The roof of the cover is packed with 6 inches of leaves, held in place with burlap. The name of the case is that of the orginator, Mr. C. H. Root, of Red Bank, New Jersey.

The quadruple case is a wooden box, the sides of which are fastened together with hooks and eyes. This box is 50 inches long, 46 inches wide and 27 inches deep. It is just large enough to slip down over the bottom, which is also made of lumber, and is not in any way attached to the sides. The fitting is sufficiently close to prevent mice from making their way into the packing. The cover is a shallow box, the outside of which is covered with good roofing paper, made just large enough to telescope over the body.

PLATE IV.

Photograph of the winter cases: left—hives uncovered; middle—hives with Root cases; right—hives with Holterman cases.

On the floor, 4 pieces of 2 x 2-inch lumber, each 3 feet long, are laid in such a fashion as to form supports for the hives. The bottom is then covered 2 inches deep with leaves or planer shavings.

The 4 hives were then set on these supports in pairs back to back, and the passageway from the entrance of each to the six ⅜-inch holes, which were bored through the cover wall exactly opposite, kept open by inserting a rectangular box with one open end over the hive entrance and the other over the holes. The entire space was then filled with leaves and the cover put in place. The bottoms of the hives were thus insulated 3 inches—1 inch of lumber and 2 of leaves; the sides were protected by 8 inches, the fronts by 6, and the tops by 12.

The colonies were packed about December 1, but the thermometers, owing to delay in their receipt, were not inserted until February 9. The colonies were opened and the data taken April 20.

Winter covering is put on for purposes of insulation and it was to be expected that its effect would appear in the more stable temperatures obtained. Stability of this sort is greatly to be desired because the amount of energy necessary to maintain the needed temperature, and consequently the loss of bees by exhaustion and the amount of stores used, are reduced

The effects of the different types of cover on temperature changes is shown by the four columns of figures. The first shows the conditions in the hives protected by the C. H. Root cover, the second those in the hives in the quadruple cases, the third those in the unpacked hives, and the fourth the temperature out-of-doors.

It thus appears that the bees protected by the C. H. Root case were able to maintain both the highest and the most stable temperatures.

The effects of these conditions are shown in Table VIII.

Table VIII

Results of Experiment in Wintering Bees

Group	TREATMENT	No. of Colonies	Stores Per Colony at the Beginning, lbs.	Average Stores at the Close, lbs.	Average No. of Frames of Brood at Close	No. Dead
1	C. H. Root case,	9	20	8	$1\frac{1}{3}$	0
2	Quadruple case,	12	20	$5\frac{5}{7}$	1	2
3	Unpacked,	9	20	$6\frac{1}{3}$	$\frac{1}{3}$	4

The nine colonies with the C. H. Root cover used less stores, had more brood and experienced no losses. The twelve colonies in the quadruple covers used more stores, had less brood, and lost 2 colonies. The unpacked hives used less stores than the quadruple cases, but more than those covered by the C. H. Root cases, had the least brood of all, and lost 4 colonies.

It is thus clearly shown that the insulation paid well and that the C. H. Root insulator gave the best results. The actual number of inches of insulation about the hives protected by the C. H. Root case was less than in the quadruple covers, but it is, of course, applied in a different way. This fact would seem to indicate that the thickness of the insulating material is not always a measure of its efficiency and that the method of applying may be an important consideration. (Plate II, p. 501.)

Miscellaneous

White grubs. Last year the entomologist found as the result of some preliminary experiments that three-fourths of an ounce of carbon bisulfide per square foot of red shale soil destroyed all grubs (principally *Lachnosterna fusca* Froehl) when applied at a temperature ranging from 70° to 75°F., and that one ounce per square foot used under the same conditions did not injure one-season-old mixtures of blue grass and white clover.

This year Mr. William H. W. Komp undertook as the subject of his undergraduate major thesis the study of carbon bisulfide as a destroyer of white grubs. By methods which are explained in his paper he reached the following conclusions: (1) that from ¾ to 1 ounce of carbon bisulfide will destroy all grubs in a red shale soil in a temperature of 70°F. up; (2) that the degree of soil moisture which will give the results is neither very dry nor very wet but medium; (3) that the cost for material ranges from $135 to $180 an acre, and that its application, while effective, is not practicable save in limited areas.

The Cattelya fly. The orchid pest, known as the Cattelya fly, was made a subject for an undergraduate thesis by Mr. Jared B. Moore. Mr. Moore's investigation revealed the fact that this insect is really a limiting factor in the commercial production of orchid blooms; that under our greenhouse conditions, although its life cycle covers from 4 to 6 months, it is almost constantly emerging; that the destruction of the larvæ without serious damage to the plant by cutting out, or injecting carbon bisulfide, chloroform, ether or tobacco juice, or by raising the temperature either under dry or moist conditions is impracticable; that the adult fly does not yield to the strength of tobacco normally used in greenhouse fumigation.

The Onion thrips. A little work on this insect was undertaken in coöperation with Mr. R. W. DeBaun, extension specialist in vegetable gardening, on the farm of Mr. Theodore Brown, of Swedesboro. "Black-leaf 40" (1 to 1,000) plus soap (2 lbs. to 50 gal.) was thoroughly applied under high pressure with an orchard sprayer when the thrips first appeared. Although the onions were large, in 10 days there was a marked difference between the sprayed and the unsprayed plots.

Corn ear worm. The application of powdered arsenate of lead and sulfur (consisting of 1 part of lead to 1 part of the sulfur) to sweet corn plots in Atlantic, Cumberland, and Cape May Counties, eliminated about 80 per cent of the normal injury. The work was done by the farm demonstrators in coöperation with Mr. DeBaun.

Onion Maggot. The sodium arsenite and molasses spray bait consisting of ⅕ of an ounce of sodium arsenite, 1 gallon of water, 1 pint of molasses and a small amount of aqueous onion extract, was tried by Mr. DeBaun and the farm demonstrators in Cumberland, Mercer, Monmouth and Gloucester Counties with most encouraging results. The protection obtained is such that a large increase in demonstration work along that line is planned by Mr. DeBaun.

Melon aphis. Tobacco extract and soap—"black-leaf 40" (1 to 500) plus soap (2 lbs. to 50 gal.) were used as a spray for cantaloupes on more than a dozen farms in South Jersey, under the direction of Mr. DeBaum, and found satisfactory to control the melon aphis.

Coccidæ of New Jersey Greenhouses. Mr. Harry B. Weiss,[1] assistant to the State entomologist, has prepared a list of the scale insects found on the greenhouse crops of the State. The list follows.

ICERYA Sign.

I. purchasi Mask. On acacia, orange, lemon.

ORTHEZIA Bosc.

O. insignis Dougl. On coleus, gardenia, verbena, citrus, chrysanthemum, tomato and other plants.

PSEUDOCOCCUS Westw.

P. citri Risso. On bouvardia, coleus, citrus, fuchsia, croton, ferns, bay trees, tomato, palms, geranium and many others.

P. longispinus Targ. On ferns, citrus, palms, dracena, coleus and many others.

P. pseudonipæ Ckll. On Kentia sp. and Cocos sp.

CEROPLASTES Gray

C. cirripediformis Comst. On citrus.

C. floridensis Comst. On citrus, oleander.

EUCALYMNATUS Ckll.

E. tessellatus Sign. On palms.

COCCUS Linn.

C. hesperidum Linn. On bay trees, oleander, crotons, begonias, palms, ficus, citrus, cyclamen, orchids, camellia and many others.

C. longulus Dougl. On citrus, ficus, euphorbia, ferns and others.

C. pseudohesperidum Ckll. On orchids (Cattleya and Dendrobium spp.).

SAISSETIA Depl.

S. hemisphærica Targ. On palms, ferns, oleander, croton, orchids, citrus, camellia and many others.

S. oleæ Bern. On camellia, citrus.

DIASPIS Costa.

D. boisduvalii Sign. On palms, orchids.

D. bromeliæ Kern. On pineapple, oleo fragrans, latania.

AULACASPIS Ckll.

A. zamiæ Morg. On cycas revoluta.

HEMICHIONASPIS Ckll.

H. aspidistræ Sign. On ferns, aspidistra, pandanus, orchids.

FIORNIA Targ.

F. fiorniæ Targ. On camellia, palms, ficus, orchids and others.

ASPIDIOTUS Bouche.

A. britannicus Newst. On bay trees.

A. cyanophylli Sign. On palms, orchids, ficus.

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[1] Weiss, H. B., Psyche, v. 23, pp. 22–24.

A. hederæ Vall. On orchids, palms, cycads, oleander, citrus, ivy and many others.
A. rapax Comst. On bay trees, palms, camellia.

CHRYSOMPHALUS Ashm.

C. conidum Linn. On palms, pandanus, ficus, bay trees, camellia, citrus.
C. aurantii Mask. On citrus, palms, pandanus.
C. dictyospermi Morg. On palms, pandanus latania.
C. perseæ Comst. On orchids.
C. rossi Mask. On orchids.

TARGIONIA Sign.

T. biformis Ckll. On orchids.

LEPIDOSAPHES Schimer.

L. beckii Newm. On citrus, croton.
L. gloverii Pack. On palms, citrus.

ISCHNASPIS Dougl.

I. longirostris Sign. On palms, pandanus.

PARLATORIA Tag.

P. pergandii Comst. On citrus.

The above verifies most of the records furnished by Dr. W. E. Britton for Smith's 1909 list of "The Insects of New Jersey," and increases the number of greenhouse species from 19 to 32.

Periodical Cicada. Recently it has been possible to get together the facts relative to the distribution of the periodical cicada, or 17-year locust, in this State. In the year 1902 a summary of the situation was published[1] and what follows is an effort to bring the matter up to date. Brood VIII is to be expected next year. The entomologist is indebted to Mr. Harry B. Weiss for preparing the following statement and the accompanying list.

Brood II

1877—*Union, Essex, Morris, Monmouth* Counties in large numbers; *Warren* Co., Hainesburg; *Sussex* Co., Monroe Corner.

1894—*Bergen* Co., throughout, especially from Tenafly, Carlstadt, River Vale, Mahwah. *Passaic* Co., Paterson, Greenwood Lake district. *Sussex* Co., Huntsburg and Papakating. *Morris* Co., Boonton and eastern districts. *Essex* Co., everywhere. *Hudson* Co., everywhere, except flats and marshy portions. *Union* Co., everywhere. *Somerset* Co., in a few localities. *Warren* Co., Rocksburg. *Hunterdon* Co., northwestern corner. *Mercer* Co., along road to Hightstown. *Middlesex* Co., irregularly distributed, more plentiful north of Raritan River, becoming less toward south and west; along Raritan River from Perth Amboy to Bound Brook; Jamesburg. *Monmouth* Co., slight in eastern part. *Ocean* Co., in small patches; Toms River, Cassville. *Burlington* Co., in small patches; Pemberton. *Camden* Co., Pensauken, Clementon; along *Camden* and *Atlantic* and Reading Railroads toward Atlantic County line. *Gloucester* Co., Franklinville and north of this at several places; along line of Cape May Railroad. *Salem* Co., Friesburg. *Atlantic* Co., irregular throughout; Hammonton to coast along Atlantic City Railroad. *Cumberland* Co., irregular

[1] Weiss, H. B., Ent. News, v. 27, pp. 337–339.

throughout; between Bridgeton and Millville; along railroad from Vineland to Cape May County line. *Cape May* Co., throughout in large numbers, except on lowlands; plentiful at Woodbine.

1911—*Bergen* Co., from Fort Lee northward to New York State line; along top of Palisades and on both slopes; none in Hackensack valley and in low marsh areas; Rutherford, Ramsey, Westwood, Tenafly, Carlstadt, River Vale, Mahwah, Englewood, Alpine. *Passaic* Co., Paterson, Totowa, Little Falls; along line of S. & W. Railroad they extended to Morris County line; in Lake Macopin region; Hackensack. *Sussex* Co., Sparta, Newton, Huntsburg, Papkating. *Warren* Co., L. & W. Railroad to Lake Hopatcong; Morristown, Morris Plains; from Newfoundland and Charlottesburg to Sparta along line of S. & W. Railroad; Newark watershed, Chatham, Denville, Dover to Wharton, Mendham, Millington, Mt. Tabor; north and south of Dover; Pleasant Hill in patches; Mt. Olive. *Essex* Co., infested everywhere. *Hudson* Co., Snake Hill; very little Cicada ground now remains in this county. *Somerset* Co., Washington Valley back of Pluckamin and along road to Basking Ridge; in spots from Bound Brook to Bernardsville; Somerville, Raritan. *Hunterdon* Co., High Bridge, throughout hills southeast toward Lebanon; Fairmount, Lambertville, Stockton, Ravenrock. *Union* Co., Roselle, Fanwood, Summit, Elizabeth, Springfield, Rahway; county generally covered in much reduced extent. *Middlesex* Co., New Brunswick, College Farm; from Stelton to Union County line; along north bank of Raritan River from Bound Brook to county line; Rahway to Perth Amboy; Metuchen to Perth Amboy along north bank of Raritan River; Old Bridge, Milltown, South Amboy. *Mercer* Co., between Hightstown and Yardville; Princeton. *Monmouth* Co., Matawan, Cliffwood. *Ocean* Co., around Lakewood, South Lakewood; west of Lakewood, Ridgeway. *Burlington* Co., no records. *Camden* Co., Clementon; along line to Atlantic City Railroad to Atlantic County line; Almonesson, Blue Anchor, Florence to Williamstown Junction, and along this branch to Gloucester County; Haddonfield. *Gloucester* Co., Woodbury, Malaga; along line from Williamstown to Glassboro. *Atlantic* Co., irregularly throughout on gravelly knolls or areas. *Cumberland* Co., Husted, Bridgeton; Bridgeton to Rosenhayn along Central Railroad; Vineland, along trolley line between Malaga and Newfield; Millville, irregular throughout county. *Salem* Co., between Elmer and Palatine only. *Cape May* Co., all wooded areas of peninsula in gravelly lands; Woodbine, Ocean View, Tuckahoe, Dennisville, Sea Isle Junction, Wildwood Junction, Seaville, Swain, South Seaville.

Brood VI

1881—*Essex* Co., Caldwell in small numbers.

1898—*Middlesex* Co., Piscatawaytown. *Passaic* Co., Charlotesburg. *Morris* Co., Hanover. *Cumberland* Co., Vineland.

1915—*Union* Co., Cranford. *Essex* Co., Upper Montclair. *Passaic* Co., Oak Ridge. *Mercer* Co., Princeton.

Brood VIII

1900—No records in Smith's reports. *Essex* Co. (Marlatt).

Brood X

1885—*Burlington, Camden, Mercer, Middlesex, Monmouth, Morris, Passaic, Somerset, Hunterdon* Counties.

1902—*Warren* Co., southwestern corner; well covered south of Central Railroad of New Jersey and along Delaware River. *Hunterdon* Co., southern half. *Mercer* Co., pretty well distributed, except in extreme south. *Somerset* Co., not heavily visited, except at Rocky Hill, Middlebush, Martinsville, Franklin Park, Bound Brook, Raritan, Somerville, Neshanic, Three Bridges, Harlingen, Kingston, *Middlesex* Co., Piscatawaytown. *Monmouth* Co.,

Highlands of Navesink, Locust Point. *Ocean* Co., New Egypt, Collier's Mill, Prospertown; between Jacobstown and Ellisdale (Burlington Co.). *Burlington* Co., Ellisdale, Indian Mills. *Camden* Co., Delaware Township. *Salem* Co., Salem, Yorktown, Woodstown. *Gloucester* Co. Swedesboro and between Swedesboro and Harrisonville. *Cumberland* Co., Shiloh; no records from Hudson, Essex, Bergen, Union, Passaic, Sussex, Cape May, Morris and Atlantic Counties.

Brood XIV

1889—*Bergen* Co., Englewood. *Mercer* Co., Princeton. *Burlington* Co., Palmyra. *Gloucester* Co., Red Bank.
1906—No reports of occurrence, except in Bergen County, by Marlatt.

Brood XV

1890—*Essex* Co., *Cape May* Co., Anglesea.
1907—*Cape May* Co., *Union* Co., Plainfield to Westfield. *Morris* Co., Newfoundland.

Leptoypha mutica Say. Recently this species, which was recorded by Dr. Smith in 1909 as rare and having been taken at Madison only, was reported by Mr. Weiss and Mr. Dickerson[1] as damaging every leaf on the fringe bushes (*Chionanthus virginica* L.) in a nursery at Hammonton. "The injury first appears as a slight, whitish discoloration on the upper surface along the midrib, due to the abstraction of sap by the insect along the undersurface. These whitish patches gradually enlarge until the leaf has a mottled appearance, and in severe infestations the entire leaf becomes yellowish-brown and withers completely. When the plants are growing in the sun, most of the insects are found on the under sides of the leaves, but in shaded situations and when the foliage is dense, many of the nymphs are found on the upper surfaces. After the second stage the nymphs seem to migrate somewhat and feed singly and in colonies on any portion of the leaf which is shaded. No particular portion of the plant seems to be preferred, as entire bushes were found infested from top to bottom."

Tropidosteptes saxeus Dist. This bug, which was recorded in 1909 from New Brunswick on ash, has recently been reported from Somerville, Millburn, South Orange, Kingston, Springfield, Irvington, Rutherford, Morris Plains and Elizabeth by Mr. Weiss and Mr. Dickerson. The species is reported by the above as causing a white spotting of the upper surfaces of the leaves by feeding on their undersurfaces. Severe infestations cause the leaves to dry and curl. The adults appear at New Brunswick in the latter part of May and early June. Eggs are laid in the midribs of the younger leaves. Adults of the second brood appear the latter part of August.

Stephanitis pyrioides Scott. Recently this species of lace bug (the azalea lace bug) has become abundant enough to do a considerable amount of damage to azaleas. Mr. Weiss and Mr. Dickerson carried out an investigation of the species and reached the following conclusions: (1) it is known to

[1] Dickerson, Edgar L., and Weiss, H. B., Ent. News, v. 27, p. 308.

occur at Arlington, Rutherford, Far Hills, Riverton, Palmyra, Springfield, Nutley and New Brunswick in New Jersey, at Bala in Pa., in Washington, D. C., and in Hollands and Japan; (2) it has probably come into New Jersey in the egg stage on evergreens and azaleas from Japan; (3) it attacks Hinodegeri, Amoena, Ledifolia alba, Benigeri, Yodogawa, Kæmpheri, Pontica, Mollis, Indica, Shirogeri, Hatsugeri, Shibori, Amurasaki, Schilippenbachii, etc., but is less severe on the deciduous than on the evergreen ones; (4) injury is due to robbing the foliage of sap, and when severe may cause the leaves to become white; (5) it winters in the leaf in the egg stage and has three broods per season; (6) it may be controlled by spraying with whale oil soap at the rate of 5 to 6 pounds of soap to 50 gallons of water just after the winter eggs have hatched. The spray must hit the under sides of the leaf.

Monarthropalpus buxi Lab. This small fly, known commonly as the European boxwood leaf miner, has recently assumed the position of a pest of considerable importance. Mr. H. B. Weiss has had an opportunity to make a study of it and reports the following conclusions: (1) this insect is now known to occur at Rutherford, Far Hills, Gladstone, Peapack, South Orange and Eatontown, and will doubtless be found in other places in the near future; (2) it has been introduced from Holland within the past five years; (3) it has been taken on freshly imported stock from France and Holland, especially the latter; (4) the uniform green of valuable plants is ruined by yellowish spotted leaves and in bad cases with dead and dying foliage; (5) egg laying begins in the latter part of May and doubtless continues through early June, the eggs are laid in the leaves and as many as 35 eggs have been found in a single leaf under laboratory conditions, the eggs hatch and the yellowish-white maggots mine the leaves all summer and pass the winter in the mines and transformation to pupæ occurs in the spring; (6) that, considering the damage which this midge is capable of doing and the lack of really efficient remedies, together with the fact that partly injured boxwoods are no longer ornamental, it would seem that prompt destruction of the infested plants before the adults emerge in the spring should prove the best method of control.

VI

THE RESPONSE OF THE HOUSE-FLY TO CERTAIN FOODS AND THEIR FERMENTATION PRODUCTS

C. H. Richardson

Introduction

Experience teaches that the house-fly, like most insects, seeks its food largely by means of a keenly developed olfactory sense. The present paper gives the results of a series of experiments conducted at New Brunswick, N. J., during the summer of 1916 on the response of the house-fly to certain foods and their fermentation products. It is a continuation of the writer's work on responses of the house-fly to environmental factors, a part of which has already appeared (5).

Investigation of the food preferences of this insect is beset with numerous difficulties. Climatic conditions, especially temperature and light, affect its activities, but more puzzling is the great difference in abundance often observed on two consecutive days when conditions of temperature, moisture and light appear to be nearly uniform. Many explanations suggest themselves, such as the appearance of new broods, disposition to migrate and the desire to vary the diet. Under such conditions it is paramount that all experiments be repeated a number of times as isolated experiments may lead to entirely erroneous results.

The data given here must be considered a preliminary treatment of this subject, awaiting further verification and extension.

One of the first studies made on the food preferences of the house-fly was reported by Morrill (4). A large number of substances, including sucrose (cane sugar), cane syrup, vinegar, bread, bran, sweet and sour milk, fresh and stale beer, fresh and decomposed meat, fresh and decomposed fish, dead flies, dried blood and a number of less complex chemical substances, including ethyl alcohol, formaldehyde solution (40 per cent), potassium dichromate, cobalt and water were used alone and in various combinations. Some of the results obtained have a bearing on the present investigation. Sucrose was comparatively unattractive when used in aqueous solution with formaldehyde. The addition of 95 per cent ethyl alcohol (1 part to 20 parts of water), increased its attractiveness. Vinegar in combination with sucrose was eagerly sought by house-flies. Vinegars contain from 3 to 9 per cent absolute acetic acid and it is possible that this was responsible for the result, although one cannot assume too much since vinegar is a very complex product. Ethyl alcohol when added to beer did not form an attractive mixture. The explanation is probably to be found in the fact that the mixture contained too much alcohol. American beers have an alcohol content of from 3 to 5 per cent ethyl alcohol. The addition of dilute alcohol (1 to 10) would raise the alcohol content of the solution to a point which would render it less attractive. The experiments reported here show that 10 per cent ethyl alcohol is considerably less attractive than 4 per cent. Morrill's studies further point out the irregularity of response to the same bait on different days.

Buck (2) conducted a series of experiments similar to Morrill's. He advocated not less than 3 per cent or over 8 per cent of 95 per cent ethyl alcohol when used in water alone. Sucrose was found to be a valuable addition to various baits, sometimes increasing their attractiveness from 10 to 20 per cent.

Methods

The experiments were conducted on a shelf along the south side of a barn, in a well-lighted location, where flies were always plentiful. Screen-wire fly-traps, 9¼ inches high and 6 inches in diameter at the base, were used in all experiments. The screen was given a coat of spar varnish to prevent rusting. White glazed earthenware dishes, 122 m.m. in diameter at the top, with a capacity of 125 c.c., were used as containers for the various solutions. The metal traps, pans, and the earthenware dishes were care-

fully washed at the conclusion of each experiment. All solutions were made up with distilled water.

Special care was exercised to see that no trap containing the same material occupied the same location in two consecutive experiments. The traps were placed in a linear series along the shelf 3 feet apart. During the course of a series of experiments, a single material was exposed near the east and west ends and near the middle of the space occupied by the traps. As far as possible, the same trap was not used twice consecutively with the same material Unless otherwise stated, only one portion of a substance was used in each experiment.

The results given apply only to the house-fly (*Musca domestica* L.), although a number of other species often frequented the traps. Careful counts and estimates made throughout the course of these experiments show that more than 95 per cent of the flies captured were house-flies. The percentage of other species was a little higher during July, but diminished during August.

All the substances used in these experiments captured, on the average, nearly equal numbers of males and females.

EXPERIMENTS WITH CARBOHYDRATES

Carbohydrates form a large part of the foods which the house-fly ordinarily ingests. It was therefore decided to test the attractiveness of aqueous solutions of some of the carbohydrates of wide occurrence in nature. Glucose (dextrose), fructose (levulose) and galactose were chosen from the monosaccharides, maltose, lactose, and sucrose (cane sugar) from the disaccharides and dextrin and starch from the polysaccharides.

Solutions of 1 gm. to 50 c.c., 2 gm. to 50 c.c. and 5 gm. to 50 c.c. of distilled water were employed and 50 c.c. were placed in each trap. The experiments with galactose were not completed because of the difficulty of obtaining this compound. The results of these experiments are expressed in Table IX.

On the whole, these carbohydrates in aqueous solution were not very attractive to house-flies. Considering all the experiments, lactose caught the largest number of flies, starch the least. Dextrin also caught a comparatively large number of flies. Sucrose was consistently a poor bait. There were often great variations in the numbers caught on different days, which frequently bore no relation to the length of time the traps were exposed.

From the foregoing experiments I believe it is safe to state that the carbohydrates of common occurrence, at least when not undergoing fermentation, are not very attractive.

EXPERIMENTS WITH ALCOHOLS AND ACIDS

The decomposition of foods containing large amounts of the fermentable sugars results in the formation of a long list of compounds, prominent of which are ethyl alcohol, carbon dioxide, acetic acid, lactic acid, fusel oil, and succinic acid. It is practically impossible to control the fermentation in any food mixture so that one or even two or three compounds will form at the exclusion of all others. For this reason it was decided to experiment with dilute solutions of certain of these fermentation products both in aqueous

Table IX

Response of the House-Fly to Carbohydrates

* Material in 50 c.c. Distilled Water	1 gm. 7/12–15 75 hrs.	1 gm. 7/15–18 67 hrs.	1 gm. 7/14–18 89 hrs.	2 gm. 7/20–21 28 hrs.	5 gm. 8/22–23 22 hrs.	5 gm. 8/23–25 41 hrs.	5 gm. 8/25–28 70 hrs.	5 gm. 8/29–30 20 hrs.	5 gm. 8/30–31 24 hrs.	5 gm. 8/31–9/2 45 hrs.	5 gm. 9/2–4 47 hrs.	Total Last 4 Experiments	Average Last 4 Experiments	Average Per hr. Last 4 Experiments
Glucose (Dextrose), ...			3	1				11	5	1	9	26	6.5	0.19
Fructose (*Levulose*), ...								3	1	5	76	85	21.2	0.62
Galactose, ...			0	63										
Maltose, ...			1	14	2	21		5	2	1	8	16	4.0	0.11
Lactose, ...			0	0		90	62	14	24	1	13	52	13.0	0.38
Sucrose, ...			0	2		7	6	2	2	7	2	13	3.2	0.09
Dextrin, ...					2	23		3	44	28	35	110	27.5	0.80
Starch, ...	1	2						1	2	1	5	9	2.2	0.06
Water (control), ...			0*	4*										

* Two traps used in each experiment.

solution and in solutions with certain carbohydrates. In this way mixtures reasonably free from impurities can be obtained.

It should be stated at this point that the amylic alcohol (technical) used in these experiments was a mixture of isoamyl and active amyl alcohols, the *former predominating. These alcohols, together with some others, are found* in the fusel oil obtained from crude spirit by distillation. They are derived from the amino acids in mixtures which are undergoing alcoholic fermentation.

Table X gives the results of these experiments:

Table X

Response of the House-Fly to Alcohols and Acids

Material	8/28–29 22 hrs.	8/29–30 20 hrs.	8/30–31 24 hrs.	8/31–9/2 45 hrs.	9/4–7 66 hrs.	9/7–8 30 hrs.	Total	Average Per Experiment	Average Per Hr. (All Experiments)
50 c.c. 4% Ethyl alcohol	146	67	37	82	14	545	891	148.5	4.30
50 c.c. 10% Ethyl alcohol	19	21	12	156	3	333	544	90.6	2.62
50 c.c. 4% amylic alcohol (tech.)	142	123	106	292	17	576	1256	209.3	6.06
50 c.c. 10% amylic alcohol (tech.)	203	41	31	59	7	778	1119	186.5	5.40
50 c.c. 4% acetic acid	88	22	2	101	4	235	452	75.3	2.18
50 c.c. 10% acetic acid	173	11	4	17	8	1029	1242	207.0	6.00
50 c.c. 4% lactic acid	5	5					10	5.0	0.23
50 c.c. 10% lactic acid	39	11					50	25.0	1.19
50 c.c. 4% succinic acid	64	12					76	38.0	1.80

Four per cent ethyl alcohol was considerably more attractive than 10 per cent. Four per cent amylic alcohol (technical) was slightly more attractive than 10 per cent. Ten per cent acetic acid was more attractive than 4 per cent. Lactic and succinic acids were also attractive, but too few experiments were performed with them to lead to any conclusions.

Amylic alcohol (tech.) of 4 per cent concentration caught more flies than any other substance used in this series. Although the averages per experiment and per hour of 10 per cent acetic acid closely approach those given for 4 per cent amylic alcohol (tech.), a comparison of the individual experiments will show that amylic alcohol (tech.) gave more consistent results. Amylic alcohol (tech.) was more than twice as attractive as 10 per cent acetic acid in 4 experiments, while the acetic acid was more attractive (though not twice so) in two experiments.

EXPERIMENTS WITH CARBOHYDRATES IN SOLUTION WITH ACETIC ACID AND ALCOHOLS.

Aqueous solutions of maltose, lactose, sucrose and dextrin containing ethyl alcohol, amylic alcohol (tech.) or acetic acid were made, 5 gm. of carbohydrate to 50 c.c. of solution being used. The alcohols and acetic acid were used in 4 per cent concentrations. The results are stated in the following Table:

Table XI

Response of the House-Fly to Solutions Containing Carbohydrates, Alcohols and Acetic Acid

Material, 5 gm. in 50 c.c. of Solution	8/22–23 22 hrs.	8/23–25 41 hrs.	8/25–28 76 hrs.	Total	Average Per Experiment	Average Per Hour
Maltose and distilled water,	2	21	....	23	11.5	0.3
Maltose and 4% ethyl alcohol,	0	500	....	500	250.0	7.3
Maltose and 4% acetic acid,	*5*	*100*	....	*105*	*52.5*	*1.8*
Maltose and 4% amylic alcohol (tech.),	638	440	....	1078	539.0	17.1
Lactose and distilled water,	....	90	62	152	76.0	1.2
Lactose and 4% ethyl alcohol,	....	160	200	360	180.0	3.0
Lactose and 4% acetic acid,	....	60	175	235	117.5	2.0
Lactose and 4% amylic alcohol (tech.),	....	270	450	720	360.0	6.1
Sucrose and distilled water,	....	7	6	13	6.5	0.1
Sucrose and 4% ethyl alcohol,	....	155	78	233	116.5	1.9
Sucrose and 4% acetic acid,	....	75	28	103	51.5	0.8
Sucrose and 4% amylic alcohol (tech.),	....	550	380	930	465.0	7.9
Dextrin and distilled water,	2	23	....	25	12.5	0.3
Dextrin and 4% ethyl alcohol,	11	400	....	411	205.5	6.5
Dextrin and 4% acetic acid,	0	150	....	150	75.0	2.3
Dextrin and 4% amylic alcohol (tech.),	2	944	....	946	473.0	15.0

In every case the attractiveness of the carbohydrate was increased by the addition of amylic alcohol (tech.), ethyl alcohol or acetic acid. Amylic alcohol (tech.) was more effective when used with a carbohydrate than when used alone; indeed, with maltose and dextrin, it appeared to be remarkably effect-

ive. Ethyl alcohol was more attractive with maltose and dextrin than when used alone, but less so when used with lactose and sucrose. Acetic acid seemed to be a little more attractive when used alone than when added to solutions of the carbohydrates employed in these experiments.

While these experiments are not as extensive as one might desire, when compared with the results obtained in the experiments on carbohydrates and on acids and alcohols, they form a significant series.

EXPERIMENTS WITH OTHER FOOD SUBSTANCES

Wheat Flour. Bread has often been used as a fly bait, and, when added to other food mixtures, it seems to enhance their attraction to house-flies almost invariably. This led into a study of the response of house-flies to certain constituents of wheat flour, but it was not possible to pursue this work very far in the time allotted.

The studies on carbohydrates showed that starch, at least when not undergoing chemical change, was practically unattractive. Wheat flour, in addition to its large starch content, is rich in proteins, principally gliadin and glutenin with smaller quantities of water-soluble proteins. It was therefore decided to test the attractiveness of certain wheat proteins.

By kneading white wheat flour dough in water till practically all the starch granules have been freed, it is possible to prepare a substance consisting largely of gliadin and glutenin known as crude gluten. The crude gluten cannot be entirely freed of water-soluble protein by this method.

One gm. of crude gluten in 50 c.c. of water was used in each trap. Other traps contained an equal amount of wheat flour in 50 c.c. of water. Two experiments were made with the following results: Crude gluten and water, 2 traps in each experiment, total 6 flies. White wheat flour and water, 2 traps in each experiment, total 332 flies; control (water), 2 traps in each experiment, total 7 flies.

In view of the poor success of the crude gluten it did not seem advisable to try gliadin and glutenin separately.

Other experiments were made with solutions containing the starch granules (in suspension), and all the water-soluble constituents except those removed with the crude gluten. Results of these experiments follow: 1 gm. starch and water-soluble constituents in 50 c.c. water, 3 traps, total 2,112 flies; control (water), 2 traps, total 3 flies; 1.35 gm. starch and water-soluble constituents in 50 c.c. water, 2 traps, total 7 flies; same, 2 traps, total 218 flies; 2.5 gm. starch and water-soluble constituents in 50 c.c. water, 2 traps, total 855 flies; control (water), 2 traps, total 4 flies.

These experiments with solutions containing the starch and water-soluble substances of wheat flour indicate that some of the ingredients are attractive to the house-fly.

Further experiments with solutions containing only the water-soluble substances present in wheat flour (the suspended starch being removed by filtration) gave the following results: 0.1 gm. water-soluble constituents in 50 c.c. water, 3 traps, total 4 flies; control (water), 3 traps, total 1 fly; 0.1 gm. water-soluble constituents in 50 c.c. water, 2 traps, total 2,400 flies; control (water), 2 traps, total 21 flies.

While too much reliance cannot be placed in this small number of experiments, the indications are that the water-soluble constituents alone of wheat flour are eagerly sought by house-flies.

Milk. Milk is uniformly a good fly bait. It is, however, like wheat flour, so complex that any adequate study of its attractiveness to the house-fly would require considerable time. A few tests were made on fresh milk in the following manner. The milk was acidified with dilute acetic acid until the casein was precipitated. The liquid portion was separated from the solid casein, which also held much butterfat, by filtration. In two experiments, the casein-fat mixture did not attract flies. Treatment with ether removed the butterfat. The fat-free casein caught 77 flies in one experiment; 10 c.c. of butterfat (ether extract) caught 2 flies in one experiment.

These experiments merely indicate that fat-free casein is attractive, while butterfat is not.

PRACTICAL APPLICATION

A number of experiments with poisoned baits were conducted during the summer. Previous work of Mally (3) in South Africa and Berlese (1) in Italy has demonstrated the effectiveness of solutions of molasses poisoned with sodium arsenite as a bait for house-flies. Several tests made at New Brunswick with Mally's formula or slight modifications of it gave fair results. The molasses solution was spread over boards and rockwork where flies were abundant, and although many were killed, the method was not as successful as was anticipated.

Two trap experiments with molasses solution (25 c.c. molasses in 75 c.c. water) to which 1 gm. of sodium arsenite and 4 c.c. amylic alcohol (tech.) were added to each 100 c.c., gave 2,000 and 468 flies, respectively. In the same series a solution of the water-soluble part of wheat flour with the starch in suspension (1.35 gm. in 50 c.c. water) containing the same amount of sodium arsenite and amylic alcohol (tech.) captured 1,052 and 206 flies, respectively. The attractiveness of the wheat flour solution was greatly increased by the addition of amylic alcohol (tech.). Four per cent acetic acid solution of wheat flour, containing sodium arsenite, was not as attractive as the solution without acid. The addition of both acetic acid and amylic alcohol (tech.) (4 per cent concentrations) gave little better results than when amylic alcohol only was added to the solution.

The following mixture was used with considerable success in a barn: black strap molasses 800 c.c., water 1,600 c.c., sodium arsenite 24 gm., amylic alcohol (tech.) 100 c.c. This mixture was placed in shallow pans in which bits of straw were dropped. Although cool, cloudy weather prevailed during the course of the experiment a considerable number of flies were poisoned.

Amylic alcohol (tech.) is scarcely soluble in water, and for this reason it is impossible to distribute it evenly throughout an aqueous solution. Moreover, it is quite volatile and usually disappears within 24 hours.

Conclusions

The following conclusions are drawn from these experiments. As stated elsewhere in this article, they must be considered as tentative, awaiting more extended investigation.

(1) Glucose, fructose, galactose, maltose, lactose, sucrose, starch and dextrin were not very attractive to house-flies. Lactose and dextrin caught the largest number of flies, starch the least. Sucrose was consistently a poor bait.

(2) The acids and alcohols lured flies in the following order: 4 per cent amylic alcohol (tech.), 10 per cent acetic acid, 10 per cent amylic alcohol (tech.), 4 per cent ethyl alcohol, 10 per cent ethyl alcohol and 4 per cent acetic acid. Succinic and lactic acids showed some attractive qualities in two experiments.

(3) Maltose, lactose, sucrose and dextrin in 4 per cent solutions of amylic alcohol, ethyl alcohol and acetic acid were more frequently visited by house-flies than the corresponding aqueous solutions. Maltose and dextrin solutions were more effective than lactose and sucrose. The order of response to the alcohols and acetic acid was the same as in (2).

(4) Crude gluten from wheat flour, consisting largely of gliadin and glutenin was not attractive. Solutions of the water-soluble portion of wheat flour, with or without the starch in suspension, were decidedly attractive.

(5) Several experiments with milk indicate that fat-free casein is attractive, while butterfat (ether extract) is not.

(6) Experiments suggest that aqueous solutions of molasses to which sodium arsenite and amylic alcohol (tech.) are added have considerable value as a poisoned bait for house-flies. The water-soluble portion of wheat flour containing the starch in suspension also gave good results with the same additions.

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Report of the Mosquito Work for 1916

THOMAS J. HEADLEE

The attention of the entomologist and his assistants have this year been directed to finishing the work contemplated under four contracts that were executed but not finished last year, to general oversight of the county mosquito work, and to extending such aid along mosquito control lines to various organizations and individuals applying for it as the means at hand would permit. The funds of 1916 were so limited as to forbid the letting of any new contracts.

SALT-MARSH DRAINAGE IN 1916

The entomologist has found so many discrepancies in the statements relative to the amounts and kinds of drainage established on the salt-marsh and so little solid information on which to base a complete statement that he has begun the gathering of the data necessary to a complete detailed statement of the entire matter. Until the facts are in hand any further attempt to state the matter appears to be inadvisable.

Table XII

Salt-Marsh Ditching Work Up to and Including 1916

PERIOD	Acres	Feet of Ditching	Cost to the State		
			Ditching	Necessary Studies and Publications	Administrations
Up to 1907, as reported, ...	15,851	2,215,524	....	11,000.00	....
In 1907, as reported, ...	10,951	1,505,524	19,400.00	....	4,100.00
In 1908, as reported, ...	6,669	888,650	15,758.00	....	4,242.00
In 1909, as reported, ...	2,672	365,800	9,917.00	539.00	4,543.00
In 1910, as reported, ...	4,650	350,000	4,471.00	....	4,242.00
In 1911, as reported, ...	8,528	712,000	19,650.00	....	4,548.00
In 1912, as reported, ...	6,195	1,000,180	21,650.00	....	2,528.00
In 1913, as reported, ...	7,174	1,564,842	21,580.00	....	5,350.00
In 1914, as reported, ...	....	1,299,840	7,583.83	....	3,350.00
In 1915, as reported, ...	....	2,685,071	13,109.23	....	4,885.40
In 1916, as reported, ...	....	2,543,713	....	....	4,718.86

Salt-Marsh Drainage in 1916

The salt-marsh drainage work carried on by the Experiment Station in 1916 consisted of bringing the contracts of the previous year to completion. The fiscal year of 1915 came to a close with four contracts still incomplete: (1) one for the cutting of 225,000 linear feet of 10 x 30-inch ditching or its equivalent on that area of salt-marsh which extends from the Bergen-Hudson dividing line northward between the Hackensack River and the highland to the west to the Paterson Plank Road, which leads across the valley southeastward from Carlstadt; (2) another for cutting 90,000 linear feet or its equivalent on that area of salt marsh which extends from the Paterson Plank Road northward between the Hackensack River and the highland to the west to the northern boundary of the borough of Carlstadt; (3) another for the cutting of 189,189 linear feet of 10 x 30-inch ditching or its equivalent on the salt-marsh area which extends from the southern boundary of Stafford Township, Ocean Co., between Barnegat Bay and the highland to the west to the northern boundary of the same; (4) another for the cutting of 209,634 linear feet of 10 x 30-inch ditching or its equivalent on the salt-marsh areas extending southward from Great Egg Harbor on both sides of Pecks Bay to the meadow boulevard or highway which extends from Ocean City to Marmora.

First Area

(All that salt marsh beginning at the southern boundary of Bergen County and extending northward, between the Hackensack River and the highland to the west, to the Paterson Plank Road.)

This area of salt marsh lies in the limits of the boroughs of North Arlington, Rutherford, and East Rutherford, and the township of Union. For convenience it was mapped in three divisions and marked, beginning at the southern border, as "Bergen Co. Map 1," "Bergen Co. Map 2" and "Bergen Co. Map 3." The first map included all the area from its southern limit northward to the Boonton Branch of the D., L. & W. R. R. The second map covered the territory from that line northward to the Erie. The third represented the marsh from Erie R. R. northward to the Paterson Plank Road.

MAP 1

In this section of marsh, which includes about 1,230 acres, 147,899 linear feet of 10 x 30-inch ditching or its equivalent was cut. Two large creeks penetrate this area and determine the type of drainage. Saw Mill creek forms most of its southern boundary and Kingsland Creek runs through it near its northern boundary. By means of a southward running branch of Kingsland Creek and Fox's Ditch the water from one creek can pass into the other. When the work began the connection had been almost entirely closed by plant growth. Furthermore, the upper courses of both creeks had become shallow through the accumulation of sediment, and at one point in its lower course the channel of Kingsland had been obstructed by throwing pieces of old timber, principally railroad ties, into it. To make a bad matter worse at every extra high tide the water of the river passed over its banks and spread

on the back portions of the marsh. In fact, the drainage conditions were such that large portions of the marsh surface were never free from water except during a dry period of considerable length.

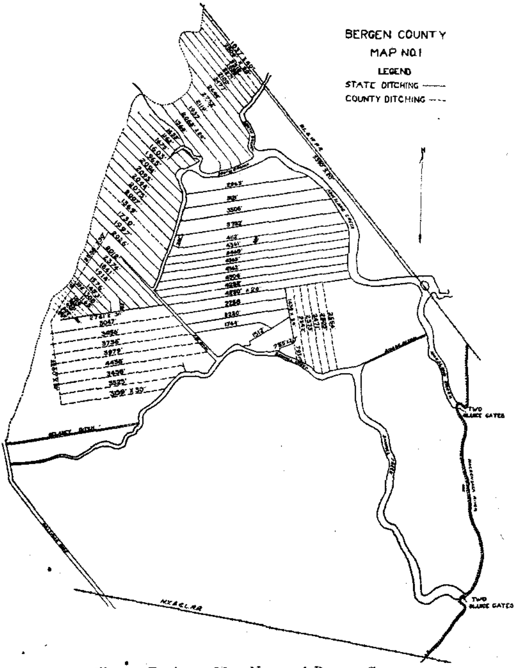

Fig. 4.—Drainage Map No. 1 of Bergen County.

The ditching had hardly begun before the heaviest kind of breeding appeared over an inundated area at the center of about 600 acres. Utmost haste was made with the trenching to run this water off and kill the brood. Time was not taken to clean the ditches out. Hardly had this area been trenched and the brood destroyed before heavy breeding appeared in Maps 2 and 3, and the gangs were hurried into these areas. The result of the haste was that while the mosquitoes were largely eliminated, the trenching was almost completely outlined before the clearing of the ditching was under-

taken. Cleaning began on Map 3 and progressed southward. As shown in last year's report, when the contractor reached the ditch clearing on Map 1 he balked, and the matter had to be referred to the attorney-general. On the attorney-general directing the contractor to complete the work by clearing the ditches on Map 1 of obstructions and putting them down to depth, he undertook and carried out the work. On June 17, 1916, the entomologist was able to certify that the work had been satisfactorily completed and that the last payment was due.

While this ditching unquestionably eliminated the worst breeding, it was neither sufficient in amount nor furnished with good enough outlets. The building of a dike along the west bank of the Hackensack River from Saw Mill Creek to the Boonton Branch of the D., L. & W. R. R., the installation of a pair of tide gates in the mouth of Kingsland Creek, and the clearing of the channel of the southern branch of Kingsland Creek, and of Fox's Ditch, thereby providing for a circulation of water through the back part of the marsh between Saw Mill and Kingsland Creek, was also planned. A technical ruling of the comptroller and his temporary hold-up of funds, for reasons explained in the last report, prevented the doing of further work on this area. The county mosquito commission undertook to supplement this work, built the tide gates in 1915, and the dike in 1916, and partly cleaned the channels of the Creek and Fox's Ditch in 1916, besides cutting 105,886 feet of additional ditching.

The area is now in good shape for ordinary seasons, but further clearing of the above outlets and the cutting of certain additional ditching will probably be found necessary to render it free from breeding under extreme high tide and rainfall.

The drainage systems established in the course of this work are shown on the accompanying map.

MAP 2

This area, which amounts to 1,542 acres, consists of a number of different subdivisions that must be drained more or less independently. At the southern end an irregular patch covering 154 acres lies between the Boonton Branch of the D., L. & W. R. R. and the Jersey City water pipe line. This section was covered with water, well-stocked with fish, showed no breeding, and received no drainage. Almost the entire northwestern corner, amounting to 700 acres, has been enclosed in a dike for agricultural purposes, but unfortunately the southern wall has been breached in two places and a certain part of the area flooded. Very little breeding was found in this section, and very little ditching was put in. A third division lies east of Berry's Creek and between the southern end of this diked area and the Jersey City water pipe line. This area was deeply flooded, showed no breeding, and was not ditched. The fourth and last section lay between Berry's Creek and the Erie R. R. Breeding was found here, and 17,669 feet of drainage were cut to relieve it.

There can be no question as to whether this area was insufficiently drained, but the breeding in Maps 1 and 3 was so much more serious that the entomologist felt justified in giving this section the minimum amount of drainage.

Since that time, in both 1915 and 1916, the county mosquito commission has cut additional ditching. The accompanying map will show both the drainage established by the Experiment Station and that cut later by the county in such a way that two can be distinguished. Even with the additional ditching, the drainage of the area is not complete.

MAP 3

This area, which consists of 1,830 acres, was found breeding between the New Jersey and New York R. R. and the highland to the west, especially at the foot of Orchard Street, where it was soaked with sewage. Both the woodlands and the marsh surrounding them, especially the latter, were found to be breeding badly. All the ditching placed in this area, amounting to 86,147

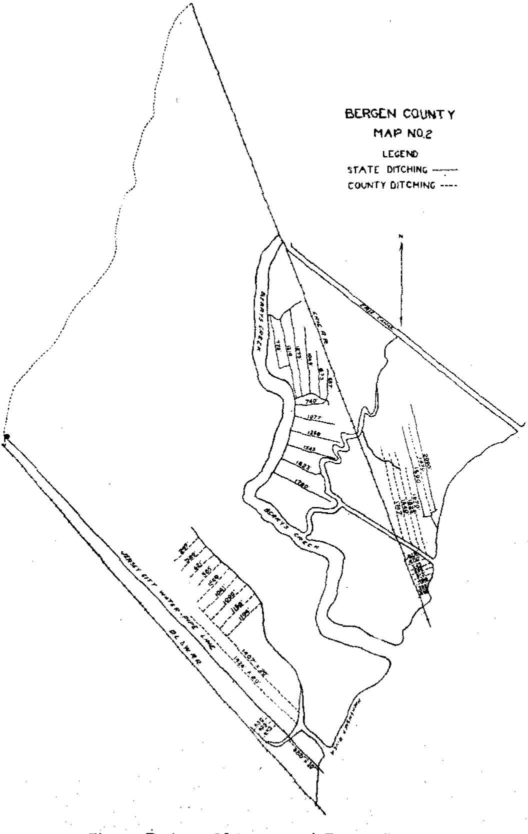

Fig. 5.—Drainage Map No. 2 of Bergen County.

feet, has been cut in the above sections. Although the drainage has undeniably eliminated the worst breeding spots in the area, the amount cut is too small to suffice for the area as a whole. A certain amount of additional ditching has since been placed in the area by the county commission. The accompanying map serves to show the details of the drainage system thus established.

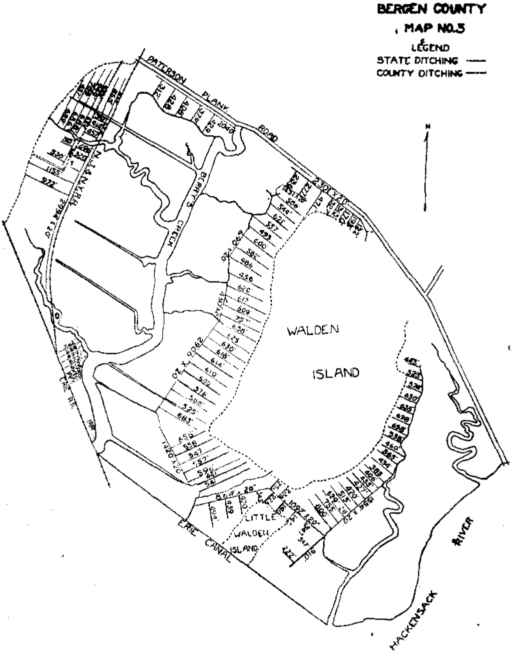

Fig. 6.—Drainage Map No. 3 of Bergen County.

A feature of the drainage in this area and in the central portion of the first area is the presence of many old stumps and roots, which in some places are so close together that the roots form an interlacing network. In attempting to cut the trenches in a root-filled region, the heavy spades could not be driven through and the contractor was compelled to resort to the axe, saw, and slicing bar. The prevalence of this condition is without doubt the principal cause of the contractor failing to finish his work on time.

Second Area (Carlstadt Marsh)

(All that salt marsh beginning at the Paterson Plank Road and extending northward between the Hackensack River and the highland to the west, to the northern boundary of the Borough of Carlstadt.)

A certain amount of ditching had been done on this area by the county mosquito commission before the contract referred to was let. A part of this drainage had been placed between the Moonachie Road and the highland to the west, while the other part had been placed just south and southeast of the larger wooded area. The ditching comprehended in this contract began on the southeast side of the large woodland and continued along the east and north sides of the same; then crossed Moonachie Creek and circled about the small woodland which lay to the eastward.

The contractor, Mr. Fred A. Reiley, proceeded during the fine weather of the fall with extreme slowness while trying to use a marsh ditching machine (one of the Eaton type). It cut fairly good ditches, even though there were many roots and some stumps, until the first one inch of the marsh surface became frozen. Thereafter neither ditcher nor hand spades could be used. Nothing further was done until the following spring. When spring came, labor was extremely hard to get, and only a small number of men were employed. This, together with the amount of stump and root underlain area delayed the work until there was no hope of finishing in the time specified. The contractor averred the extreme difficulty of getting labor, and requested an extension of time. What seemed then to be a reasonable extension was granted, but the state of the labor market became worse and worse, and a still further extension was granted. The work was finally completed on October 31, 1916.

All told, 94,667 linear feet of 10 x 30-inch ditching or its equivalent was cut in this marsh. The extra 4,667 linear feet were cut to make up the reduction in depth permitted in the upper ends of the ditches about the smaller woodland. By a change in the specifications prepared and executed according to section 10 of the specifications, the contractor's price per linear foot was cut 5 per cent for the shallowing of each inch, and he was compelled to cut as many additional linear feet of ditching as the total reduction would buy at the specified rate of 2⅔ cents per foot.

The drainage system established is as good as any that the entomologist has seen. It is not likely, however, that the combined drainage established by both the county and the State will prove entirely sufficient for the entire area specified above. The worst places are drained, but doubtless others less important exist, and a period of extreme high tide and heavy rainfall during the mosquito season will serve to bring them out.

The accompanying map sets forth the location and the nature of the drainage systems established by both State and county.

Third Area (Stafford Township, Ocean County)

(All that salt-marsh area beginning at the northern boundary of Stafford Township, Ocean County (old survey) and extending southward between Barnegat Bay and the highland to the west, to the southern boundary of the said township.)

For sake of convenience this area had been mapped in three divisions, named respectively, beginning at the north—"Stafford Township Map 1," "Stafford Township Map 2," and "Stafford Township Map 3." A large amount of ditching had already been cut in Map 1 and in Map 2.

About 84,588 linear feet of 10 x 30-inch ditching, or its equivalent, was placed in the territory of Map 1 as a means of supplementing the already existing drainage. In the course of this work three interesting and rather difficult drainage problems presented themselves. The water in Newell Ditch, which was the natural outlet for a large portion of the back part of this marsh, was stagnant, and there seemed no good way to relieve it. Finally, it was decided to open an old overgrown ditch extending from

its lower end southwestward to Cedar Creek. The result was marvelous—Newell Ditch and its dependent system began to work immediately. The second problem was to find an outlet for the section of the meadow which was flooded by a cedar swamp at the inner edge of the area. After much thought it was decided to open an old overgrown ditch known locally as

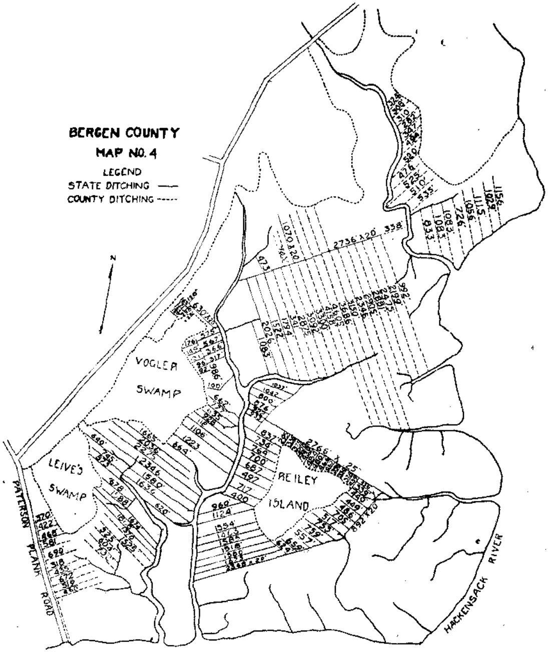

Fig. 7.—Drainage Map No. 4 of Bergen County.

"Snapping Turtle Ditch." As a result the area was promptly laid dry. The third problem was the drainage of certain pockets on a knoll at the inner edge of this marsh. The sod here varied from 10 to 2 inches in thickness and the distance to the outlet was long. The problem was solved by securing a good team of horses and a breaking plow and plowing furrow ditches by which the water was led to the outlets.

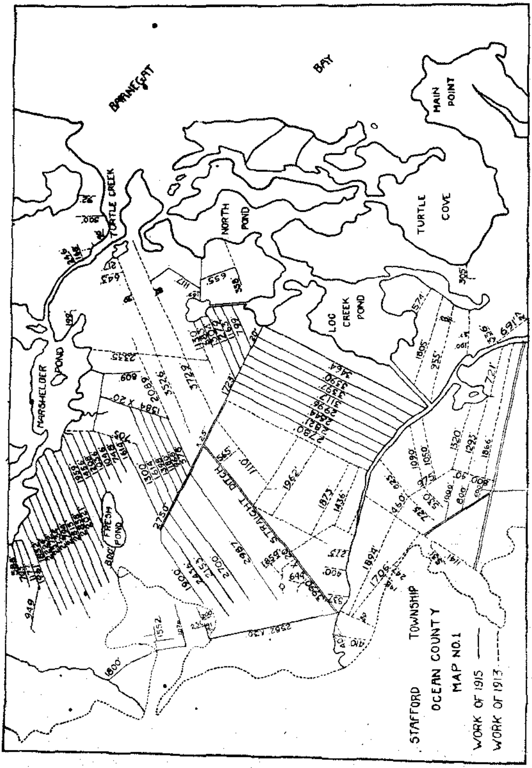

Fig. 8.—Drainage Map No. 1 of Stafford Township, Ocean County.

The location and the nature of ditching are shown on the accompanying map.

On the territory of Map 2 no additional ditching was cut as the need for it did not at the time appear.

The remainder of the drainage, amounting to 104,609 linear feet of 10 x 30-inch ditching, or its equivalent, was placed in the territory covered by Map 3 as laid down on the accompanying map. Near the upland in this area a small section, which was more or less underlain hy roots and stumps, was encountered, but the trenches were sunk to depth by the use of axe and spade.

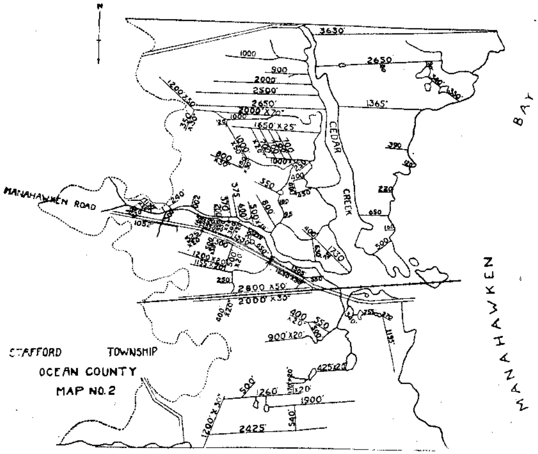

Fig. 9.—Drainage Map No. 2 of Stafford Township, Ocean County.

On April 22, 1916, the entomologist was able to certify that the drainage contemplated under this contract with the U. S. Drainage and Irrigation Co., had been satisfactorily completed.

The entomologist feels that the drainage in Maps 1 and 2 is reasonably thorough, but that a considerable amount of spurring is needed in the system established in Map 3, and that there is much undrained territory between the end of the drained area and the southern boundary of Stafford Township.

Fourth Area (Ocean City and Upper Township, Cape May Co.)

(All that salt marsh beginning on the south side of Great Egg Harbor and extending southward between the sand strip and the mainland, to the meadow Boulevard in the Borough of Ocean City and Upper Township of Cape May County.)

This section of marsh has three well-marked divisions—the island area, the area adjacent to the sand strip and the area adjacent to the mainland.

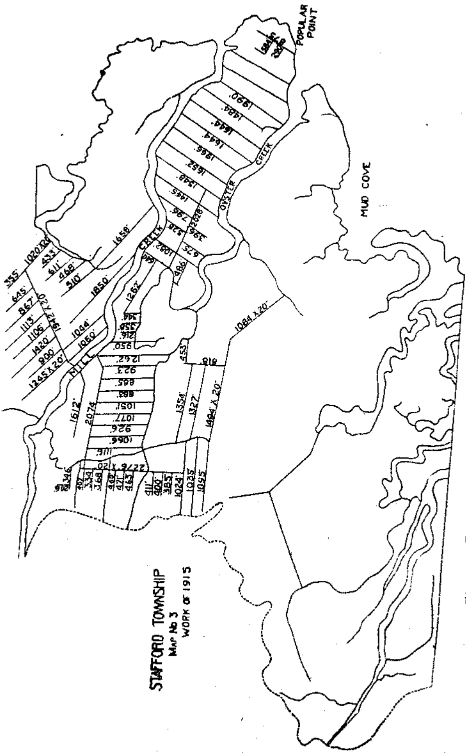

Fig. 10.—Drainage Map No. 3 of Stafford Township, Ocean County.

The first consists of a considerable number of low-lying islands, which because of the frequency with which they are flushed by the tide, do not *apparently* breed. *This section received no ditching whatever.*

Mr. Fred A. Reiley, the contractor, began the trenching at the north end of the area adjacent to the sand strip and continued southward toward the meadow boulevard. Much difficulty was experienced in obtaining satisfactory outlets for sections of the salt marsh that had been left partly surrounded by sand fills, and for areas which had been cut off from the normal outlets by railway grades. Fortunately, only a few of the former were present. Two lines of railway run parallel southward from Ocean City and both cut off considerable sections of the salt marsh from all adequate outlets, and create *great breeding places for mosquitoes. Such culverts as were in place under* the grades were for the most part set too high to afford any really effective drainage.

Effective coöperation of the city and of the railways was secured, and culverts were placed as necessary under the streets and under the railway grades in such a fashion as to establish proper outlet for the drainage cut by the State Experiment Station. The area adjacent to the sand strip was rather thoroughly drained.

Ditching on the area adjacent to the mainland began at the meadow boulevard and proceeded northward. No problems of especial interest arose because the marsh was of quite the usual type. The remainder of feet was utilized in cutting long ditches and the spurring was neglected. Without doubt this area will have to be spurred before it is thoroughly drained.

Taking the fourth area as a whole a new problem presented itself in the form of floating sods. The floating of spade sods has long been known and held as one of the drawbacks to salt-marsh drainage. Soon after this job had gotten a good start a series of high tides lifted the long ribbons, moved them in some cases a considerable distance from the places where they were originally placed. As this would greatly interfere with the harvesting of the hay an effort was made to fasten the upper ribbon, which was the one that floated badly, in place. Rough 30-inch stakes were driven through the sod into the soil below, and it was found that when placed at intervals of 50 feet they held the sod satisfactorily.

The labor problem entered into this job, as into others, and necessitated an extension of time. On September 25, 1916, the entomologist was able to certify that the work had been completed. The accompanying map serves to show the location and nature of the ditching.

In the course of the work under the contract of 1915, covering 225,000 feet *of ditching in* Bergen County *Maps 1, 2 and 3,* were found cases in which was work subsidiary but plainly necessary to the drainage system being established, but of a nature to render its equation in terms of feet of 10 x 30-inch ditching impracticable. The State Comptroller objected to the expenditure of additional money for such purposes, because the same had not been planned for in the original estimates. Accordingly, in the three following contracts certain additional sums over and above the contract price were set aside for this type of work. In the Ocean County and the Cape May County contracts, the plan worked admirably, but in the Carlstadt agreement in Bergen County, it proved almost useless.

Summary

Four separate contracts started in 1915 were finished in 1916. The first which covered the ditching in Bergen County, Maps 1, 2, and 3, was finished June 17, 1916, with 251,615 linear feet of 10 x 30-inch ditching. The second, which covered the ditching in Borough of Carlstadt, Bergen County, Map 4, was finished October 31, 1916, with 94,667 linear feet of 10 x 30-inch ditching. The third, which covered ditching in Stafford Township, Maps 1, 2 and 3, of Ocean County, was finished April 22, 1916, with 189,189 linear feet of 10 x 30-inch ditching or its equivalent. The fourth,

which covers the ditching in certain marshes in the Borough of Ocean City and Upper Township of Cape May County, was finished September 25, 1916, with 209,634 linear feet of 10 x 30-inch ditching or its equivalent.

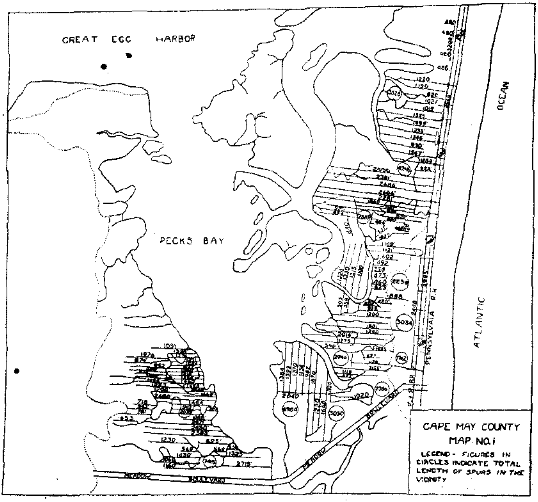

Fig. 11.—Drainage Map No. 1 of Cape May County.

Statement of 1915 Salt-Marsh Ditching Work Completed in 1916

Meadow	*Acres*	*No. of feet of 10-inch ditches or their equivalent*	*Cost*
Hackensack Valley, west of River from Saw Mill Creek north to Paterson Plank Road, ...	4,600	251,715	$4,218 75
Additional money was used in constructing temporary dike across creek just south of the D., L. & W. R. R., and also in cutting across old sunken stone roads found near Kingsland Creek, ..			106 50
Hackensack Valley, west of River from the Paterson Plank Road north to the Northern boundary of Carlstadt, ...	2,000	94,667	2,400 00
Additional money used in labor in assistance in measuring ditches in this area.			25 50

Stafford Township (old survey), ...	5,400	189,189	2,800 00
Additional money was used for the cleaning of old farmers' ditches; for plowing shallow ditches near upland and in buying stakes for the lining out of ditches, ...			272 60
Borough of Ocean City and Upper Township and Meadow Road north to end of Peck's Island on the east and Beesley's Point on west, ...	1,500	209,634	2,900 00
Additional labor in digging shallow ditches, spurring, filling holes, etc., ..			385 88
Totals, ...	13,500	745,105	$13,109 23

Throughout the areas covered by the drainage in the Bergen County contracts, sufficient ditching has been cut to protect the area treated, but as only the badly breeding parts were trenched a large part of the marsh was left totally without ditches. The areas covered by Stafford Township Maps 1 and 2 are pretty completely drained but the portion in Map 3, which has been covered, needs a certain amount of spurring. That part of the Cape May County area which falls in Ocean City has been thoroughly drained, but the part in Upper Township, which has been covered, is in need of spurring.

FINANCIAL STATEMENT OF MOSQUITO WORK

Total appropriation		$4,800 00
Equipment (lantern slides)	$14 00	
Office supplies and printing	68 85	
Telephone and telegraph	22 07	
Postage	50 50	
Salaries of regular and temporary employees..............	3,009 68	
Traveling expenses of same	1,342 80	
Clerical and laboratory assistance	151 91	
Sundries (rubber boots, motorcycle repairs, etc.).........	59 05	
Balance reverted to treasury	81 14	
		$4,800 00

SUMMARY OF MOSQUITO CONTROL BY COUNTIES

Hudson County

This is the fourth season of work for Hudson County. In addition to maintaining a regular patrol of the 10,000 acres of salt marsh and eliminating in so far as possible all breeding found, the drainage of various portions has been improved by the cutting of the equivalent of 140,000 linear feet of 10 x 30-inch ditching in the form of 20 and 30-inch-wide drains. On the 75,786 acres of upland, where more than one-half a million of people have their homes, a regular patrol was maintained throughout the mosquito season and all breeding found destroyed.

Bergen County

This is the second year of extensive work in Bergen County. Starting with an undrained salt marsh of 8,378 acres and upland of 143,470 of city,

farmland and forest, the mosquito commission aided by the State Experiment Station cut or contracted for the cutting of more than one-half million linear feet of the 10 x 30-inch salt-marsh trenching for the purpose of eliminating the worst breeding spots on the salt marsh; the county mosquito commission early in the season caused an inspection of the upland to be made and on the basis of information thus gained made an arrangement whereby each pool and swamp should be reinspected every two weeks during the mosquito breeding season and treated as might be necessary to suppress the breeding. The inspection work on the upland involved 72,252 individual examinations of individual properties and revealed the following mosquito breeding nuisances: 2,395 rain barrels, 580 tubs, 148 old wells, 349 cans, pails, etc., 153 cesspools, 170 open drains, 98 cisterns, 96 open cellars, 534 miscellaneous receptacles, 205 swamps, 56 brooks, 284 pools, 51 ponds, 160 ditches, 15 miscellaneous water-holding places of a permanent character. More than 6,590 of the nuisances were reported as being done away with.

During 1916 further attention was given to the salt marsh. In addition to maintaining a regular patrol a large amount of drainage work was done.

The drainage system on that area of salt marsh lying between the Hackensack River and the highland to the west and extending from the southern boundary of the county to the Boonton Branch of the D., L. & W. R. R. was improved by building a pair of 3 x 6-feet sluice gates with necessary bulkheads across the mouth of Kingsland Creek and by constructing a dike along the west bank of the Hackensack River from the mouth of Saw Mill Creek to the Boonton Branch of the D., L. & W. R. R. for the purpose of preventing the low-lying part of the marsh near the highland from being flooded by every extra-high tide. This was an important step in mosquito proofing this area for once the water came on the marsh it escaped, because of the small amount of fall, so slowly that the mosquitoes could reach maturity before it disappeared, especially if the tides ran extra high during the period and the weather was cloudy with consequently little evaporation. The sluices at the mouth of Kingsland Creek were described in the last annual report. The dike was a work of considerable magnitude, being 3.3 feet high, 3 feet wide at the top with a slope of 45 degrees, and 6,200 feet long.

The drainage was further supplemented by clearing a channel 3 feet wide as deep as necessary to establish a living stream from the north branch of Kingsland Creek through the south branch to Fox's Ditch and thence into Saw Mill Creek, thus establishing a circulation channel between the two main outlets—Saw Mill and Kingsland Creeks—and affording an outlet to the ditching on the back part of the marsh. Wherever the falling water revealed shoal places in Kingsland Creek channeling was undertaken and carried out.

About 100,000 feet of the usual narrow trenching was placed in this area for the purpose of relieving spots not already drained, the principal one of which lay just east of the old copper mine.

The next job undertaken by the county mosquito commission was the improvement of the drainage of a section of salt marsh designated as the

"Moonachie Meadow." This area extends from the Carlstadt ditching northward between the Moonachie Road and the Hackensack River to the Little Ferry Line. The 20-inch band ditch along the highland was widened to 30 inches and a 10-inch ditch running west from this widened into a 20-inch ditch. In addition the construction of a large sluice and bulkhead across Moonachie Creek was carried out. The sluice box is open at the top, 10 feet wide, and 12 feet long and is guarded by two gates. On one side the box was connected with the shore by a line of heavy 3-inch piling 50 feet long and on the other with a similar string 60 feet long. To prevent the high water from running around the ends of the bulkhead a string of low dike was built from each end out into the meadow, in one case 100 feet and in the other 200 feet in length.

The drainage of the Ridgefield meadow, which extends between the Hackensack River and the highland to the east from Bullman's Creek northward to the highland, was supplemented.

The county mosquito commission maintained a patrol of the upland throughout the mosquito season and eliminated all breeding found. This patrol revealed 1,690 rain barrels in which 517 cases of breeding were found, 576 tubs and 141 cases of breeding, 154 cesspools and 34 cases of breeding, 24 privies and 3 cases of breeding, 64 cellars and 12 cases of breeding, 55 cisterns and 13 cases of breeding, 25 wells and 5 cases of breeding, 32 manure pits and 3 cases of breeding, 539 pools and 194 cases of breeding, 378 ditches and drains and 185 cases of breeding, 899 sewer basins and 0 cases of breeding, 66 ponds and 16 cases of breeding, 392 swamps and 160 cases of breeding, 115 brooks and 60 cases of breeding, 8 lakes and 0 cases of breeding, 740 miscellaneous water-holding places and receptacles and 163 cases of breeding.

Essex County

This is the close of the fifth season of work in Essex County. When the year began, Essex had 3,000 of her 4,000 acres of salt marsh not only well ditched but had supplemented the original drainage system by keeping out the tide with dikes and allowing the water to escape through tide gates.

During the present season, in addition to maintaining a patrol throughout the mosquito-breeding time and applying such measures of control as the particular cases of breeding seemed to require, the county mosquito commission placed or planned to place the remaining acreage, with the exception of several hundred that had been filled and 130, under the protection of dike and sluice. All the rest of the marsh, amounting to about 500 acres, had been trenched in years previous. None of the areas in question required the building of a dike for all had railway grades of fills that could be made to serve in lieu thereof. Placing these areas under protection was therefore only a matter of building and installing sluices and tide gates.

An area consisting of about 75 acres lying east of the Central Railroad of New Jersey and extending north of the North Newark fill to the Greenville Branch of the Pennsylvania Railroad, was protected by placing a tide

gate on a large pipe that ran beneath a railroad spur into the water of Newark Bay. This area has been designated as the "Hassock Meadows." The Hamburg place section lies east of the Central Railroad of New Jersey and extends from the Greenville Branch of the Pennsylvania Railroad to the Central Railroad of New Jersey, which crosses Newark Bay. The area, which included about 300 acres, was drained by installing three sluices and tide gates in a convenient railroad spur which almost paralleled the shore of Newark Bay. Just northeast of the Central Railroad, which crosses the Bay, there lies a fringing marsh of about 30 acres in which the tide gating is not yet completed. The shore line of this area is filled and may be used as a dike. In order to save footage, the dikes along Bound Creek were given a deep foreshore and no attention paid to its meanderings. Curiously enough, breeding appeared in this foreshore and the territory had either to be repeatedly oiled or drained. The latter alternative was chosen and about 60 acres were drained with the usual narrow trenching.

About 30 acres of the Essex marsh lying between the southern section of the Port Newark fill and Maple Island Creek has been left with only the usual narrow trenching as protection. About 100 acres east of the Central Railroad of New Jersey and between Maple Island and Bound Creeks, was given a new sort of treatment as an experiment. It had already been drained by the usual narrow trenching. The number of outlets was reduced and those remaining were furnished with sluice boxes 12 x 12 inches x 5 feet and gate of appropriate size. Five such outlets were treated at a cost of $62.50. This meadow passed through the present season without serious breeding.

To provide against the possibility of a failure of present means to remove the marsh water in time to prevent the emergence of a brood of mosquitoes, one of the most low-lying and formerly the most prolific breeder of mosquitoes of any spot on the marshes, consisting of about 100 acres, has been connected with the old sewage pumping station.

The 76,746 acres of upland on which more than one-half a million people live has been carefully patrolled throughout the mosquito season, and mosquito breeding eliminated wherever found. This work has involved the making of 681,800 individual inspections of individual properties and the finding of breeding in barrels 3,441 times, in tubs 1,212, in cisterns 402, in cesspools 195, in cellars 339, in wells 115, in vats 397, in miscellaneous receptacles 2,036 times. It has involved the finding of breeding on permanent pools 2,373 times, in swamps 560, in ditches 340, and in brooks 166 times. As might be anticipated the great bulk of the breeding found was temporarily eliminated with oil, but a considerable amount of permanent work was done as shown by the fact that out of 1,363 pools 146, out of 285 swamps 85, out of 317 ditches 121, and out of 92 brooks 7 were filled, drained or cleaned in such a fashion as to eliminate the breeding.

Union County

This is the fifth season of work in Union County. The county mosquito commission has maintained a regular patrol of its 4,000-acre salt marsh throughout the mosquito season and in so far as possible has destroyed

all breeding which the drainage systems did not prevent. In addition to this work it has improved the drainage systems by cutting 13,814 feet of 10 x 30-inch ditching or its equivalent on the North Elizabeth marsh, 434 feet on the South Elizabeth meadow, and 39,708 feet on the Linden meadow, and by the placing of sluices and tide gates in the openings of the drainage channels of that portion of the North Elizabeth marsh which lies east of the Central Railroad of New Jersey.

The sluicing and tide-gating of the openings of the above salt marsh represents a new departure and was adopted after the results of a similar process on the Essex meadow had been seen. The problem in Union County was much more extensive than in Essex for the area was not only 12 times as large but the drainage outlets were much larger and more numerous. Some supplementing of the present system was rendered necessary by the fact that the marsh was so wide, about 1 mile, and the drainage channels so narrow that high water would not escape in time to prevent the maturing of large amounts of breeding. It had become obvious that either greater outlets must be opened, or the tide must be prevented from overflowing the meadow. The county commission felt financially able neither to open the greater outlets nor to inclose the area in a dike. The summer's experience in Essex with the practice of tide-gating the outlets without building a dike appeared to offer a solution for the problem of making a start and to form the first step in the process of keeping the tide out. It was decided to build sluices and tide gates to control the outlets with a view later, if necessary, to supplementing them by building a dike. All told, 6 sluices and 7 gates have been required.

The 61,304 acres of upland have been regularly patrolled throughout the mosquito season and all breeding found eliminated in so far as possible. Most of this elimination has been done by spreading oil, but a considerable amount of permanent work of draining and filling has been effected. One hundred and eighty-three of the larger breeding places such as ponds, pools, and swamps have been drained and 109 have been filled; 55 of these places have been done by the county mosquito commission, and 237 by the owners. The report of the county mosquito commission shows that of the 5,590 swamps, pools, ponds, brooks, etc., about 1,364 were eliminated in the season of 1916.

Middlesex County

This is the third season of mosquito work for Middlesex County. As in previous years the size of the appropriation forbade any attempt to cover the county, and compelled the county mosquito commission to limit its effort to a part of the problem.

Accordingly the mosquito commission gave its first attention to maintenance of a patrol of the salt marsh, to the elimination of such breeding as the present drainage systems did not prevent, and to the cutting of as large an amount of additional trenching as the funds would permit.

For the purpose of making the funds available for salt-marsh trenching go farther, one of the Eaton salt-marsh ditchers was purchased in connection with Monmouth County. By use of this machine the county

mosquito commission has been able to cut 186,100 linear feet of 10 x 30-inch ditching, or 15,000 more feet than were cut in the two previous years combined. This was done in the face of no increase in the appropriation available for salt-marsh work and a 40 per cent increase in the cost of labor.

The county mosquito commission's appropriation was increased this year by $1,000 for the purpose of permitting the commission to offer oversight in local anti-mosquito campaigns. In accordance with this provision, such service was offered to every town in the county. Metuchen, Highland Park, and Woodbridge availed themselves of the offer and the work of fresh-water mosquito control was carried on in those places.

Monmouth County

This is the second season of work for Monmouth. As was the case last year, the funds compelled the commission to limit its activity to the maintenance of a regular patrol of the salt marsh, the elimination in so far as possible of all breeding found, and to the cutting of as large an amount of ditching as the funds would permit.

The Monmouth County Mosquito Commission joined with Middlesex in the purchase of an Eaton machine and was able to cut 110,000 linear feet of 10 x 30-inch ditching or its equivalent on marshes at Belford, 6,000 feet at Port Monmouth, 18,000 at Pews Creek, 2,500 at Rumson, and small varying amounts at other points. The work at the first three places was done by machine—a total of 134,000 linear feet—while the remainder was done with hand spades.

Private citizens in the Rumson Road district raised a fund of $2,000 which was expended in especially thorough patrol of both the Shrewsbury salt marshes and of the adjacent upland.

Ocean County

This is the second year of anti-mosquito work by the county mosquito commission of Ocean. Last year the appropriation was merely large enough to clean the already established drainage, which covered about 20,000 acres of salt march and to patrol the same during the mosquito season.

This year the appropriation has been large enough to enable the county mosquito commission to clean the ditches, patrol the marsh and carry out a considerable amount of new drainage as shown in Table 13.

Atlantic County

This is the fourth season of anti-mosquito work in Atlantic County. Starting in 1913 with 50,000 acres of salt marsh and 307,409 acres of upland, the county mosquito commission had, with the help of the State Experiment Station, by the end of 1915 cut 2,843,832 linear feet of ditching, thereby draining 12,013 acres, discovered by means of a careful patrol that 19,244 acres did not require drainage, and 18,731 acres remained still to be drained. On the upland the mosquito commission maintained a patrol of the inhabited portions, destroyed all mosquito breeding found and met and solved many minor problems in upland mosquito work.

In 1916 the county commission cut, by use of two Erton ditching machines, 1,391,912 feet of ditching. On both the upland and the marsh a regular patrol has been maintained and wherever fresh-water mosquito breeding has been found it has been eliminated by draining, filling and using oil.

Table XIII

Statement of Salt-Marsh Mosquito Work in Ocean County

AREA	Number of Linear Feet		
	10 x 30-inch Trenching	Spurring	Recutting Old Wide Ditches
Barnegat City Junction to Surf City Borough,	50,000		
Between Barnegat and Waretown, ...			26,000
North and south of Pennsylvania Railroad to Beach Haven, near the upland west of Barnegat Bay, ...	6,075		
Beach Haven Creek, ...	2,109		
Peahala, ...	690		
Beach Haven Terrace, ...	6,687		
Spring Beach, ...	1,200		
South of Stinkhole Creek in Stafford Township, ...	19,087		
Spurring in Map 3 of Stafford Township, ..		2,490	
South of Mill Creek in Stafford Township...	51,182		
Contracted for in the salt marsh at the southern end of the county, ...	200,000		
Totals, ...	337,030	2,490	26,000

Cape May County

This is the first year of work in Cape May County and all the effort of the county mosquito commission has been directed toward the drainage of the salt marsh. A contract for 300,000 linear feet was let and the work up to date is as follows:

Pond Creek Marsh, ...	20,195 linear feet
Schellenger's Landing to Mill Creek, ...	52,994 linear feet
Cape Island Creek Marsh, ...	39,050 linear feet
North of Mill Creek, ...	20,000 linear feet
Total, ...	132,239 linear feet

In the hope and the expectation of giving some portion of the county quick relief, the drainage was started at Cape May City because the winds which normally carry salt-marsh mosquitoes can reach it only after passing over wide waterways, and it was to be expected that when the adjacent marshes were drained it would be free from salt-marsh mosquito trouble.

Table XIV

Salt-Marsh Drainage Done by the State Experiment Station and County Mosquito Commission

YEAR	Experiment Station Ditching		County Commission Ditching	
	Number of Feet Cut	Number of Feet Cleaned	Number of Feet Cut	Number of Feet Cleaned
1912, ...	*1,036,188		239,800	470,000
1913, ...	689,842	Minimum amt.	879,865	1,300,000
1914, ...	321,601	None	1,057,167	919,000
1915, ...	745,105	None	1,971,242	3,171,128
1916, ...	None	None	2,548,713	**500,000

* Maximum figures, probably 25 or more per cent too high.
** Blockage was removed from the entire drainage system, the above includes only complete cleaning.

Passaic County

This is the fourth season of work in Passaic County. The anti-mosquito work of the first year was limited to a small amount of demonstration work at Pompton Lakes. The second year an effort was made to control the mosquitoes in the city of Passaic. The third year the work included both Passaic and Paterson. The fourth year Paterson, Passaic and Acquackanock were covered.

The results of the first season were pretty good but the area chosen was sparsely settled and the results did not gain the credit they deserved. The results of the second season failed to be appreciated because the flights of the salt-marsh mosquito *A. cantator* swamped the effect of the absence of fresh-water species. The results of the third season were greatly minimized by the breeding which escaped from pools that were formed everywhere by the exceedingly heavy rains in early August. Nevertheless, the results were not by any means as good as more efficient organization might have made them.

In 1916, however, the organization at last reached a highly effective point and the patrol and elimination work was ably and effectively done with a result that people in the protected territory—about 215,000—were afforded a high degree of protection indeed.

The patrol maintained during 1916 by the county mosquito commission involved the making of 205,007 individual inspections of individual properties; covered 3,922 possible breeding places and 913 instances of breeding. These possible breeding places consisted of 13 vats, 947 tubs and barrels, 95 cesspools, 5 privies, 12 cellars, 1,229 cisterns, 458 wells, 17 street gutters, 540 sewer basins, 2 manure pits, 308 miscellaneous water-holding receptacles, 178 pools, 26 ditches and drains, 11 swamps, 7 brooks, 9 rivers, and 1 lake.

All breeding was promptly destroyed when found and 321 of 3,922 possible places were permanently done away with.

Somerset County

The work in this county was of a purely survey nature but the county commission intends to do a certain amount of educational work. The survey has covered all the worst breeding areas of the county, and shows that certain parts of the county have a very real mosquito problem.

Mercer County

This is the first year of active work in Mercer County and the entire effort has been limited to the Borough of Princeton and vicinity. The leaders in Princeton are without doubt responsible for the initiation of the work. The borough offered to raise $5,000 if the county board of freeholders would appropriate a like sum for the use of the county mosquito commission. To this proposition the board assented and the mosquito commission has this year had the expenditure of $10,000.

The problem here is purely one of suppressing the breeding of fresh-water mosquitoes. The salt-marsh species only rarely reach Princeton and then in negligible numbers. It can not be said that Princeton has an exceptionally large number of mosquitoes or that the malarial species are there peculiarly abundant. In fact, the malarial species at Princeton do not compare in numbers with those of certain other points in the State. It was not the annoyance of the mosquito pest that induced anti-mosquito work at Princeton but an alarming increase in the number of cases of malarial fever existing in the borough.

In the early part of the season of 1915 a meeting was called by the writer at the request of certain interested citizens to consider the problem and methods that should be adopted in solving it. At this meeting a special committee known as the "Princeton mosquito committee" was appointed and charged with the duty of working out the nature of the mosquito control problem and in so far as possible its solution. Prof. Ulric Dahlgren was made chairman.

Regarding the status of malaria in and about Princeton, the committee made the following report:

"The records of the Borough Board of Health show that in 1913 there were 64 cases of malaria reported. Many of these were not properly diagnosed and were not malaria. Twenty-five blood examinations were made—13 positive results. On the other hand a great many cases of real malaria were not reported because no physician was called in and the cases were treated by the family of the patients with quinine pills or with nostrums.

"In 1914, 131 cases of malaria were reported. Forty blood examinations were made—10 positive.

"The reports for 1915 are not yet in but will show an increase in new cases according to present indications; 65 cases—85 blood examinations—27 positive.

"The College Infirmary shows in 1912-13—10 cases.

"The College Infirmary shows in 1913-14—9 cases.

"The College Infirmary shows in 1914-15—22 cases.

"During the first third of 1915-16 there have been 10 cases.

"From the local report of many inhabitants the committee secured statements that malaria has always existed, that at times it has assumed an epidemic form and has aroused the town. But at all times it has been plentiful and these periodical crises have perhaps been the result of more virulent cases rather than an excessive number of cases. These reports have all tended to show that the most malaria has existed on the southern limits of our town along the course of Stony Brook, the Millstone River, and the Delaware and Raritan Canal.

"Dr. Raycroft, Mr. Ballinger, Dr. Stewart Paton, and the chairman of the Committee have gone over most of the ground from Kingston to the Basin and have found an excessive number of cases. Mr. Ballinger's report on his survey reads in part as follows:

"This survey included a house-to-house canvas of the southern extremity of Alexander Street and those bordering along the Delaware and Raritan Canal in the vicinity of Alexander Street; 19 houses in all. Information was obtained from 16 houses and the following results are based on that number.

"Histories were given at the 16 houses of 32 cases of malaria during 1915, averaging two cases to each house. Histories were obtained of 55 present residents having had malaria at some time during their residence in the district, making an average of 3.5 cases to each house. Of these 55 persons, only two had ever suffered from the disease previous to their residence in this district. Several houses were encountered which contained persons sick in bed with the disease at the time of the survey, others gave a history of having had malaria as long as 15 to 20 years ago, while some discouraged sufferers said that they 'always had it.' One family of eight gave a history of never having had malaria previous to their moving into this district twelve years ago, and since that time every member of the family had suffered from the disease every year. Another family of two stated that they had lived in this district and in New Jersey but three months, and were both suffering from a severe attack of the disease at the time of making the survey.

"Practically speaking, nearly every person who has lived in this district for a year or more has suffered from malaria. The average type of the residents in this district is characterized by an anæmic physical condition confirming the great prevalence of the disease. With this large reservoir of the disease adjacent to some very extensive areas breeding the *Anopheles* mosquito, no better facilities could be provided for the transmission of malaria.

"The Committee feels satisfied that the disease has been increasing during the past ten years and wish to call attention to the two main factors in this increase:

"*1st.* The presence in Princeton during the last few years of large bodies of Italians working on such large projects as Lake Carnegie, the Stadium, the two large laboratories, and other buildings. Doubtless many of these men were (and are) subject to chronic forms of malaria and supplemented the old sources of infection for the adult *Anopheles* mosquitoes that have transmitted it to our new cases.

"*2nd.* The new breeding place for these *Anopheles* mosquitoes furnished by the pools of water and swamps created by several extensive back-waters

that arose owing to the raising of the level of the Stony Brook and the Millstone River to form Lake Carnegie. Also by the degeneration of the banks of several abandoned basins, through falling earth and the growth of grasses and weeds which have furnished better conditions for *Anopheles* larvæ. This latter process has been going on for a much longer period, as much as ten or fifteen years.

"It is only fair to state at this point that for the greater part of its course the lake has improved certain large districts by converting them from swamps into open water. At the same time, however, we must declare that it has created the lesser areas spoken of above which are situated at its two heads where it is entered by Stony Brook and the Millstone River.

"It also appears that the borough has been effectually cleaned from mosquito breeding places during the past year by the Board of Health through the work of Mr. Ballinger and his assistants, and that our mosquito trouble both malarial and as a nuisance came mostly from sources outside the borough."

The town of Princeton is located on the eastern portion of the summit of an almost east and west irregularly oval ridge which slopes off rather gently in every direction. The highest point on this ridge is 227 feet above the sea. A small stream known as Stony Creek flows along the western, southern, and southeastern faces of this ridge and on the southeast aspect reaches a level of 50 feet, creating a sharp slope in that direction. At a point slightly south of east, Stony Brook joins the Millstone River and continues along the eastern aspect of the ridge.

Stony Brook and its branches form the drains for most of this ridge. A small brook takes its origin in the northeastern aspect of the ridge and runs a northeast course to the Millstone River.

Several years ago, for the purpose of creating a lake, a dam was thrown across the Millstone River just south of Kingston, and the lower valleys of the Millstone and of Stony Brook were drowned to form Carnegie Lake. The shores of the new lake were rather carefully shaped but a long succession of swamps and pools lying on the south side of the Delaware and Raritan Canal, which runs parallel to Stony Brook and the Millstone south and southeast of Princeton, that were formerly emptied by drains passing under the canal bed, having been kept full and transformed into breeding places. Furthermore, Stony Brook and low spots along its bank for some distance above the head of Carnegie Lake have become stagnant, and the more stagnant portions have become partially filled with water plants creating an ideal breeding place for the malarial mosquitoes. The Millstone from the point where it diverges from Carnegie Lake to the Pennsylvania Railroad has flooded its valley and forms a shallow marsh in which the fresh-water swamp and the malarial mosquitoes breed.

When the mosquito survey was made the main breeding areas were located along the bottom of the southern slope of the Princeton ridge, in these areas of badly-drained territory which have just been described.

The estimates prepared indicated that the first cost for the Mercer County work alone would aggregate almost $10,000 and that almost $5,000 more of the needed improvements lay in Middlesex County. The operations recommended were draining, filling, bank trimming and ripraping.

The county mosquito commission placed Mr. C. S. Sincerbeaux of Princeton in charge and took up the work on the basis of the recommendations of the committee.

On August 10, 1916, the writer went over the work with Mr. Sincerbeaux. The work in the borough which he believes he is paid for by the borough, seemed to be pretty well looked after, although some breeding was found. The first and only large piece of work examined was the filling of two large deep depressions between the canal and Stony Brook, well above the head of Carnegie Lake. This is a large job, involving the expenditure of about $3,500. For the purpose of permitting the operation to take place with the least trouble, Mr. Sincerbeaux caused the level of Carnegie Lake to be lowered a foot and thereby discovered a unique and probably one of the most important anti-mosquito measures in the whole problem. This lowering of the water left a muddy and pebbly beach and rendered almost the entire lake edge free from breeding by giving the fish access to all parts. The writer at once recommended that the process be repeated annually as soon as heavy breeding appears and that the level be left down until the university opens in the fall.

Information concerning progress since August 10, 1916, is not at hand.

Effectiveness of the County and State Work

The effect of the large amount of work, which has just been outlined, should be pronounced. It might be expected to appear in at least three forms, a very decided reduction in the numbers of the pest, approval of the people who have been protected, and in the advancement of taxable values.

Before attempting to discuss these points it is necessary to define what is meant by the protected districts. The present area in which all species are combatted includes all of Hudson County, most of Bergen, less than half of Passaic, all of Essex, all of Union, Metuchen, Highland Park, and Woodbridge in Middlesex, Rumson district in Monmouth, Atlantic City, Pleasantville, Hammonton and other towns and villages in Atlantic County and Cape May City in Cape May County. The work has been going on longer and is better organized in Hudson, Bergen, Passaic, Essex and Union Counties than elsewhere. The sole exception to the above statement is Atlantic County where, owing to an immense undrained salt marsh both in Atlantic and adjacent counties, the work of local control is obscured by flights of salt-marsh mosquitoes. It can be said, however, that Atlantic City has enjoyed an immunity, especially this year, through this work that is scarcely second to any in the State and, what is still more remarkable, both Pleasantville and Hammonton have had such relief as they have not before known.

In Middlesex the county commission kept the salt-marsh species down in a satisfactory manner and had very good results in the municipalities mentioned. In Monmouth the same conditions obtained with the exception of the Belford and a portion of the Manasquan areas where considerable amounts of breeding matured, owing to inadequate drainage. In Ocean the effort was limited to the control of breeding of the salt-marsh

mosquito within the drained area. Of course, mosquitoes bred in the undrained marshes between Seaside Park and Barnegat Junction and to the southward of the ditched area along the mainland migrated as far to the north as Forked River and in some cases farther. With the exception of very small issues in overlooked places the territory from Toms River north to Point Pleasant was very free from the salt-marsh mosquito. In Cape May County the salt-marsh drainage had just made a start and an effort was made by the Board of Health of Cape May City to control the fresh-water species. It was not until nearly the end of the season that the adjacent marshes were drained.

It thus becomes clear that we must look mainly to the northeastern section of the State for the most tangible effects of mosquito control work. With the exception of a few limited areas within the protected district covered by the five counties of Hudson, Bergen, Passaic, Essex, and Union, the number of mosquitoes is but a small fraction of what they were in years before the work began. This is the universal testimony of practically all the thinking people who have lived in the district long enough to pass judgment. Two years ago the scheme of determining the extent and density of the mosquito fauna by regular collections of mosquitoes on the wing, was put into practice and a comparison of the collections of this year with those of last show that the control work of this year left but a fraction of the number that survived the efforts of the preceding season. The mosquito is not exterminated in these districts but many of the householders declare that they have seen none all summer. With a few exceptions, where uncontrolled local breeding has let off enough mosquitoes to be troublesome, the mosquito pest has been severe nowhere throughout the protected areas. These conditions obtained in spite of the fact that in many of the unprotected areas the mosquito pest was very severe, especially previous to August.

The approval of the people served has been most satisfactory. The newspapers have strongly endorsed the effectiveness of the work, many organizations and individuals have expressed themselves as pleased with the protection which the work has afforded.

It seems yet too early for the increase in taxable values due to successful mosquito control to be discerned.

MOSQUITOES OF THE YEAR

It has occurred to the writer that the best method of giving a picture of the mosquitoes of the year is to select excerpts from the weekly issue of the "Mosquito Exterminator."

April 24. "A brood of *A. cantator* with a few *A. sollicitans* is on the marshes from Cape May to Jersey City. The wrigglers are growing slowly and range from very small to nearly full grown. Emergence of such as are not destroyed may be looked for early in May. Mr. David Young, inspector in charge of the work in Passaic County, reports the finding of *A. sylvestris* in small numbers."

May 1. "Mr. Young, of Passaic County, reports that he is unable to find any widespread or heavy breeding of *A. sylvestris.* He has made an especial study of this matter because he feared the tremendous abundance of this species late last summer might be followed by a large brood early in this season." "The brood of wrigglers now on the Atlantic coastal marshes have made but little growth during the past week and no pupæ

whatever have been reported. The impression seems to be that the size of the brood on the drained marshes is negligible. No brood can safely be considered negligible so long as it exists in discoverable numbers in easy reach of supposedly protected populations. On the undrained marshes near the upland the breeding among the partially submerged grasses is heavy and larvæ one-fourth of an inch long were on the twenty-seventh taken in water reading 48° F."

May 30. "The first spring brood of salt-marsh mosquitoes, which began emerging May 1 at Cape May Point and on May 6 in the lower Hackensack Valley, has completed its emergence and apparently reached its maximum of distribution. It travelled in troublesome numbers from the salt marshes of the bay coast at least as far north as Bridgeton and from the lower Atlantic Coast far into the Pines of Ocean, Burlington, and parts of Atlantic Counties. It was present in troublesome numbers in various parts of Cape May County. It is a pleasure to report that the people living adjacent to the drained marshes of Atlantic, Ocean, Monmouth, Middlesex, Union, Essex and Hudson Counties were not troubled by this brood. The trouble experienced near the Belford meadows in Monmouth, the Cheesequake meadows in Middlesex, the stump lots and Frank Creek section of the Kearney marshes of Hudson, the Kingsland, Lyndhurst, Rutherford, and Carlstadt meadows of Bergen was of short duration and at no time severe. It is of great interest to note that the areas which showed infestation sufficient to attract attention lay adjacent to or within easy reach of incompletely-drained salt marsh, as shown by the fact that the Belford meadows are almost without drainage, the Cheesequake meadows need additional drainage in certain parts, the Kearney meadows of Hudson County, especially those portions which lie just west of the Hackensack River and are known as the "Cedar Stump Lots" need additional ditching, and that the drainage of the Kingsland, Lyndhurst, Rutherford and Carlstadt marshes is incomplete. Furthermore, the places within the reach of the partially-drained marsh have been less troubled than by the corresponding brood of last year, and Passaic County, which last year was rather severely punished by this brood, is this year reported free from it. It is certainly not without significance that more than 100 miles of the coast, all of which are in reach of the drained or partially-drained salt marsh, have been free from mosquitoes or markedly less troubled than last year, while those parts within reach of the undrained salt marsh have had mosquitoes abundantly. It is further of great importance to note that Atlantic City and the shore road to the west of it have not been troubled and that this portion of the coast lies adjacent to several miles of drained marsh while huge undrained areas lie both to the north and south of it. The experience with this and previous broods has demonstrated that broods of mosquitoes can be eliminated and adequate protection given by a rather incomplete but vigorously working systems of drainage when supplemented by careful oversight, the digging of short supplementary ditches and the application of a small amount of oil at the right time. It has further shown that dependence upon drainage systems without careful oversight leads to the emergence of serious numbers of mosquitoes, regardless of how complete the drainage system may be. The first step in the spring is to see that the existing drainage systems are in good working order, and the work of a repair must be started early enough to have it completed before the first of May. As the brood approaches maturity, oil should be placed near bad spots and the remnant of the brood should be promptly oiled off as soon as pupation begins."

June 6. "The second brood of salt-marsh mosquitoes got on the wing the latter part of last week. Along the Delaware Bay coast the issue was large enough to be troublesome. Neither Atlantic City nor the shore road lying west of it have been troubled. North of the Mullica River a large brood escaped and worked its way north and northeast. On Saturday the entomologist found the northern border of this brood at Barnegat. He was informed by Mr. Stephen Johnson, who is in charge of the work in Ocean County, that this brood first appeared at Manahawkin, which

lies four miles to the south of Barnegat, on the morning of the same day. How far this brood will migrate up the bay cannot at this time be told. It had already flown five miles northward on the drained marsh. From Barnegat north to Middlesex County this brood appears to be negligible. In Middlesex, Union, Essex, Bergen and Hudson Counties the same satisfactory conditions are reported."

July 5. "About the middle of July during each of the past three years a great brood of the salt-marsh mosquitoes has emerged and invaded territory, which up to that time had been free from the pest. That time this season is now approaching and while our present information does not show the marshes unusually wet, all persons doing salt-marsh mosquito control work would do well to keep their areas under especially careful and close observation. Provisions for the prompt and efficient destruction of that portion of the brood which the drainage does not eliminate from the ditched marsh should be made. The fresh-water swamp mosquito is more troublesome than it has been in any previous year with which we are familiar. In many parts of the State, which are without timber and free from the salt-marsh mosquitoes, it was the first species to appear, and up to the present has remained the dominant form. The only parallel of this condition with which we are familiar was seen late last summer when the fresh-water swamp mosquito bred everywhere in the temporary pools which were created by the tremendous rainfall of early August. Does the dominance of this species indicate a change in its habits and a corresponding complication of the problem of mosquito control? Whether it does or not every effort should be made to find and eliminate its breeding places and thus to reduce it at least to its former status."

July 12. "The drained salt marshes are this year drier than they have been at this period of the year in any of the preceding three seasons. By this date in previous years a large brood of salt-marsh mosquitoes has been in course of development. This year the drained marshes show little breeding. In the course of a meeting of chief inspectors of Passaic, Bergen, Hudson, Essex, Union and Middlesex, held in Newark on July 10, it developed that in all these counties the dominant fresh-water mosquito for the last two months has been the fresh-water swamp species. This bears out the point made in the last issue of the 'Exterminator'—that the habits of this well-known species appear to have changed and that it is now breeding much more generally than was the case in previous years. The reports submitted at this meeting showed that mosquitoes on the wing at this time were scarce or absent, and that no complaints of trouble were being received."

July 18. "The conditions on the drained salt marsh continue good and no broods of considerable size have anywhere gotten under way. Here and there a small brood has started and in a few instances a small number of adults have escaped. The practice of assuming that any part of a salt marsh where water exists is and will continue free from breeding is a dangerous one which will sooner or later permit the escape of a brood of size sufficient to cause serious annoyance. Complete removal of all stagnant water appears to afford the only real assurance that breeding will not occur. Water of a stagnant nature which for any reason cannot be removed should be kept under the most careful scrutiny and the examinations should be both exhaustive and frequent. The fresh-water mosquito conditions are reported good throughout the protected districts."

July 25. "On Tuesday and Wednesday of last week Dr. Jacob G. Lipman, director of the New Jersey Experiment Stations, Mr. Alfred Gaskill, director of the Department of Conservation and Development, and Dr. Thomas J. Headlee, entomologist of the New Jersey Experiment Stations and executive officer in charge of mosquito work, made a trip along the coast from Jersey City to Ocean City for the purpose of observing the prevalence of mosquitoes. At the outset, and before beginning the coastal trip proper, an examination was made of the northern and northwestern parts of Union and Essex Counties, southern Bergen and eastern Hudson. Mosquito conditions were determined by daylight collections. All collec-

tions were five minutes in length and were made in shady places in the midst of bushes or high weeds. Speaking generally, few or no mosquitoes whatever were taken nat any station until Barnegat was reached. The largest collection previous to that point was taken at Forked River where five specimens were secured. The next to the largest was found in Weequahic Park where four were caught. The most significant thing in the collections was the absence of the dominant form of salt-marsh mosquito, the white-marked variety. When the undrained marshes were reached there was an obvious increase in the mosquitoes, but there was not that overwhelming onset which usually marks the transition from drained to undrained marsh. The reader will remember that in the two last issues of the 'Exterminator' mention was made of the absence of the usual heavy brood of wrigglers in early July and that the conditions of the marsh were whatever were taken at any station until Barnegat was reached. The experience of this trip shows beyond question that no general brood issued during the middle of July. The recent tides have been high and accompanied by storms, and at several points local salt-marsh broods are developing. The fresh-water mosquito control is at present very good although many of the unprotected sections of the State are suffering severely from the house mosquito. The time of the mosquito fighters trial is at hand. Practically all pools of whatever nature are warm enough to breed and the mosquito can complete its development in the minimum time. Only the most vigilant can hope to cope adequately with the mosquito pest at this time of the year."

August 1. "We are gravely informed by an editorial writer in a recent issue of the 'New York Evening Post' that the mosquito pest has invaded New York City and has not been satisfied with attacking persons who live on or near the ground, but has appeared in places as high as the twenty-ninth floor, that although science has turned her hand to the job of mosquito extermination the beast is still unconquered and the coming of the fearless knight who shall slay the pest is eagerly awaited by the tortured ones. This able writer says that Dr. Doty almost conquered the mosquito in Staten Island and that Dr. Howard had done a good deal toward reducing the pest. In New Jersey within 50 miles of the editorial office from which these 'facts' emerged live fully a million people whose homes border on the salt marshes of Newark Bay and the Hackensack River, the home of the 'Jersey bird,' from which, by the way, according to metropolitan newspaper opinion, formerly came New York City's supply of mosquitoes. Thousands of these people are occupying their unscreened porches every pleasant evening without being troubled by mosquitoes and better, still occupying their sleeping rooms without disturbance. With the exception of a few limited localities the hundreds of thousands of people in this area have experienced a relief from the pest which they characterize as a wonderful improvement. Shortly after the mosquito pest appeared this season in New York City, one evening a gentleman whom the writer knows well was crossing the Hudson from New York to the Jersey side. The mosquitoes were bad in the ferry boat slip on the New York side and the passengers were slapping them energetically. In the midst of the turmoil a voice suddenly said 'wait till we get across to Jersey, then we will get away from the mosquitoes. We used to have them over there but now we don't.' These facts not to mention the more than one hundred miles of marsh-bordered coast which is under patrol and the summer resorts that have been freed of mosquitoes, are overlooked by the Post's editorial writer. Why should a great newspaper constitute itself a bureau of misinformation? The first of August is here and no great brood of mosquitoes has emerged from the drained marshes yet. About ten days ago the undrained marshes of New Jersey and of Long Island gave off a tremendous brood of the white-marked salt-marsh mosquito and all the upland within reach has been flooded. The record of the partly-drained marsh has again shown that the only safe drainage is that which eliminates all stagnant water. All standing water on the marsh is potentially dangerous."

August 9. "At the meeting of the chief inspectors of Hudson, Bergen, Passaic, and Union Counties held in Newark, at 2:00 P. M. yesterday it was shown that the month of July and the early part of August had passed without serious mosquito trouble. Breeding in both fresh and salt water was reported wherever water had stagnated and the general impression was given that breeding during the latter part of July and early August had been hard to overcome."

August 15. "The tides have been running high and many of the salt meadows are wet. A brood of the white-marked salt-marsh mosquitoes (*A. solicitans*) has hatched and is developing. Present reports do not show the extent of the marsh involved but do indicate that it is sufficientnly large to warrant the sharpest attention by all persons charged with the duty of controlling salt-marsh breeding. The temperatures are high and but little more than a week will suffice for the pest to pass from hatching of egg to winged mosquito. The recent dry weather has dried up many breeding pools but has reduced the brooks and permanent pools to a place where they are breeding. The work of controlling the swamp mosquito, the house mosquito and the malarial mosquito will admit of no relaxation. Mr. David Young, inspector in charge for the Passaic County Mosquito Commission, reports the breeding of the swamp mosquito (*A. sylvestris*) in the sewage-polluted water of the Passaic River above the dam. This record was made by collecting the larvæ and breeding out the adults."

August 22. "The August brood of salt-marsh mosquitoes is on the wing, and again the drained and patrolled marshes have stood the test. The reports from different counties, which are due the latter part of this week, will reveal in detail the nature of this issue of mosquitoes. Mr. Leslie, chief inspector of the Bergen County commission, reported on August 18 substantially as follows: Collections, even when made along the edge of the meadow, show a marked scarcity of *A. cantator* (the brown salt-marsh mosquito), and Mr. Kraft, who lives in the meadows beside the Paterson Plank Road, reports but few mosquitoes about his house. Speaking generally the collections show some *sylvestris* (the fresh-water swamp mosquito) and a few *pipiens* (the house mosquito). In Englewood, Tenafly, Ridgewood, Bogota, and Leonia we find mosquitoes on the wing to be very scarce indeed. During the present season the only places which have even at times had serious trouble with mosquitoes are Hasbrouck Heights, Woodbridge, Carlstadt and certain parts of Haworth and of Hackensack. The collections from Union and Essex Counties with which the writer is familiar, show that the salt-marsh species have been reduced to a point where they are nowhere abundant. They also show that the fresh-water swamp mosquito is the dominant species and that *pipiens* are scarce. Both Mr. Gies and Mr. Dobbins report that the number of mosquitoes on the wing is small enough to render this the best year they have thus far had in their respective counties of Union and Essex. Mr. Young, of Passaic County, reports a very satisfactory freedom from mosquitoes in the protected parts of his county, and the results of his collections, which the entomologist has the privilege of seeing, bear out his statements. The people of Paterson and Passaic are to be congratulated on the freedom from the mosquito pest which thus far this season has been theirs and should give Mr. Young the credit which is due him. Mr. Paterson reports the control of salt-marsh mosquitoes in Middlesex County as thus far good, but not entirely complete on every part of the marsh. Mr. Van Note, of Monmouth County, reports in much the same strain as Mr. Paterson. He points especially to the absolute control obtained on the Shrewsberry River. Mr. Johnson, of Ocean County, reports mosquitoes in large numbers as far north at Barnegat, and in steadily diminishing numbers as far north as Toms River. Between Toms River and Point Pleasant he reports very satisfactory control. Mr. Reiley, acting chief inspector of Atlantic County, said under date of August 18: 'The entire inspected area of the county is practically free of *pipiens*' (the house mosquito). 'We

still have a few of the salt-marsh brood of three weeks ago and expect a large issue from the undrained marshes between the nineteenth and twenty-first. Taken as a whole, Atlantic County for the time of year has never been in better condition regarding mosquitoes.' Mr. Beckwith, in describing a collecting trip from Cape May City to Woodbine, said: 'Every time after leaving the coast I stopped the motorcycle to make a collection, *sollicitans*' (the white-marked salt-marsh mosquito) 'came about my head in clouds.'"

In the undrained marshes of South Jersey a vicious brood emerged during September and a small one during October. On the drained marshes the issue was so small as to be completely negligible.

AID EXTENDED TO ORGANIZATIONS AND PERSONS

In the course of the year the entomologist has made 80 trips relating to mosquito work, involving the giving of about 92 days of time; has prepared and mailed the "Mosquito Exterminator," and has served the New Jersey *Mosquito Extermination Association* as secretary.

Mr. Charles S. Beckwith, assistant entomologist, has served as engineer in charge of the drainage work of the Cape May County Mosquito Commission during the present season and acted as advisor in mosquito-control matters to various boards of health in that county.

Last fall one year ago the Cape May City Board of Health requested the entomologist to furnish a plan for the control of local breeding mosquitoes. An investigation of conditions was made and a detailed report of breeding places prepared and submitted. Based on this report, the following recommendations were given:

There should be a house-to-house inspection made in West Cape May once every 10 days, and, as there is no sewer system in West Cape May, *C. pipiens* will be found breeding in unsealed cesspools. These should be oiled about once every 10 days. There will be found a number of out-houses, which should be oiled in the same way. The rain-water barrels and other receptacles found should be done away with entirely, or oiled once every 10 days during the mosquito-breeding season.

As you will see from the foregoing, there is evidently a considerable amount of opportunity for mosquito breeding within the limits of Cape May City, West Cape May and Cape May Point, and that the boards of health concerned could do a great deal of excellent work in protecting the people from mosquitoes that are bred right at home. Of course, the large marsh mentioned by Mr. Henry Brehme, lying between Cape May City and Cape May Point, has already been taken care of. The report is intended to point out the main lines along which a local mosquito campaign should be run. I am not convinced that the putting on of a thorough house-to-house canvass for the control of local breeding is the best policy for the present year, because the collections thus far made in Cape May City indicate that the principal mosquito is the salt-marsh variety. On the other hand, if the people were troubled by mosquitoes in their bedrooms, it is likely that a campaign against the house species would result in affording speedy relief. All things considered, I suspect that the best plan would be for the Board of Health to undertake the permanent elimination of as large a proportion of these breeding places as possible, and to spend the minimum amount of money on the control of breeding in cesspools, privies, lot pools and sewer catch

basins. I should think that proceedings taken under the Duffield amendment to the general health laws for the year 1904 should enable the board to bring about the elimination of most of these minor permanent breeding places at the expense of the property owners.

On August 8, 1916, on request of the Board of Health of Avalon, the entomologist, accompanied by Mr. Beckwith, examined the mosquito-breeding conditions in that borough, and submitted the following report:

"At your request, I am submitting to you a statement of the results of the inspection made recently. Two places on the beach front were first examined. One on the beach just at the Casino, and the other along the shore of the Inlet, between Mr. Runk's place and the railroad.

"In the first instance, shallow ditches had been cut in such a fashion as to draw the water into certain sand pits near the beach. When the area was examined, it was obvious that the outlet ditch had not been properly graded, or had filled up, for water was standing in the ditches at the center of the area and the lower end of the outlet ditch was dry. I would suggest regrading of the outlet ditch. Mr. Hall's man informs me that he examines this area once every week, and whenever wrigglers are found in the water, promptly oils the surface of the ditches. Until this area can be filled, I am inclined to think that this is the best plan.

"In the second area a system of shallow ditches has been cut. Here the grading of the outlet ditch is not satisfactory, for, while the ditches were all dry yesterday, in many places in the upper course the bottoms were a greenish-brown, indicating unmistakably that water had stood in them long enough for a heavy growth of algæ to take place. When the water finally dried up, this growth of algæ was left on the ditch bottom, and soon assumed the color mentioned. I would suggest that a good outlet ditch, extending well up into the area, be cut, of sufficient depth that the tide will ebb and fall in it from one end to the other, and that the water will run from it into this central ditch. This central ditch will furnish the area with an abundance of killifish, which will ordinarily make it unnecessary to use oil. It was suggested by an employee of Mr. Hall's that a central sump, or hole, be dug, that all drainage of this area be turned into it, and that the water be pumped out over the beach as often as accumulated. This plan, if carried out completely, would, undoubtedly, be successful; but, entirely aside from the question of expense, the human factor in starting the pumps at the right time is large, and the chances are that the area would produce mosquitoes before the water was removed. Under the other plan, so long as the ditches are kept open, nature takes care of the situation and acts when action is needed.

"Several small lot areas, something like three or four, were examined in the upper portion of the borough. In no case was there any indication that drainage was practicable. Filling seemed to be the only real remedy. Oiling at regular 10-day intervals throughout the breeding season until such filling is done should prevent breeding.

"An area located in the woodland just south of the sewage disposal plant was considered, and I am informed the level of the bottom of this depression is naturally lower than the outlet which is provided. I am also informed that ordinary high tide is sufficient to penetrate the culvert opening under the roadway. Now, if this is true, it seems to me it would be well to lower the level of the outlet ditch until high-tide water can be sent strongly in the said depression, in order that killifish may be brought in and mosquito larvæ destroyed. This would probably take care of the situation until such time as the area is filled.

"We then went south on the roadway until we came to a truck grower's home, below which there seemed to be a little improvement on the sand strip. Here I noted a considerable number of enclosed pockets, apparently depressions, between the sand dunes, one of which just dried up, and, in dry-

ing up, had apparently given off a brood of mosquitoes. I have no doubt that a considerable number of these pockets exist south of this point. Breeding in such places can be prevented only by the use of oil until such time as they can be drained or filled.

"It might be well to have a board of health inspector charged with the duty of looking after these and other permanent breeding places and see that they are oiled whenever breeding occurs in them.

"We then drove south on the new Stone Harbor–Avalon road, and noted that the road builder had cut off a good many natural drains and had provided little passageway for the water to escape. I saw one culvert, and it seems to me more should be put in. I am inclined to think that the cutting off of these natural drains will make it necessary to establish an artificial drainage system, such as might be brought about by cutting a 20-inch ditch, 30 inches deep, about half way between the sand dunes and the roadway, and connecting the same with culverts underneath the roadway. It is, or course, assumed that the culverts will be placed at points where the natural drains lead off into the thoroughfares, and that they will be set sufficiently low to take care of the water at low tide.

"In closing this brief report, we desire to congratulate the Borough of Avalon on the small amount of breeding places found on and along the sand strip. The amount of filling done is enormous, and most of the worst places have been eliminated by it.

"Of course, the Borough of Avalon can never hope to be free from occasional heavy infestations by the mosquitoes which breed on the marshes until the west and southwest are drained.

"I presume that you are aware that nearly $15,000 worth of salt-marsh drainage will have been done in Cape May County by the time the mosquitoes fly next year. This is, however, only a beginning, for approximately $100,000 will be required before the marshes of Cape May County can be adequately taken care of."

THE MOSQUITO EXTERMINATOR

For the purpose of keeping all persons in the State who are vitally interested in mosquito-control work informed in the progress of the work, and to form a clearing house for mosquito-control information in general, the entomologist this year prepared and issued each week a circular under the title of "The Mosquito Exterminator." All told, 22 numbers have been issued and mailed to all members of the State association and such others as indicated a desire for them. The mailing list began on April 24, with 257 names, and closed with 435.

THE NEW JERSEY MOSQUITO EXTERMINATION ASSOCIATION

This association was formed nearly four years ago, has held three annual meetings and published an account of the proceedings in each case. The program for the fourth annual meeting is now being made up. The first year's proceedings had 92 pages, the second 136, and the third 159. The nature of the association and its purposes are well shown in the following constitution:

Article 1. The name of this organization shall be the New Jersey Mosquito Extermination Association.

Article 2. The purpose of this association shall be the advancement of the cause of mosquito extermination in New Jersey.

Article 3. The officers shall be a president, first vice-president, second vice-president and secretary-treasureer.

There shall also be an executive committee, composed of the officers, *ex officio*, and four members selected at large. These officers shall be elected annually at the regular annual meeting or convention of the Association.

A nominating committee of three, appointed by the executive committee, shall propose the names of candidates for the officees and of the four members at large of the executive committee, and shall also present such other names as are offered by petition signed by five members of the Association. Such names as are presented by petition must be in the hands of the nominating committee 10 days before the regular annual meeting. A majority vote of the membership present shall be sufficient to elect.

Article 4. This Association shall hold one regular annual meeting and such special meetings at such times and places as shall be selected by the executive committee.

Article 5. Membership in this Association shall consist of County Mosquito Extermination Commissions, Boards of Health, Boards of Trade, various civic organizations, or members of these organizations, and of persons connected with them, and of such other persons as may be interested in the work of mosquito extermination.

Article 6. Any of the organizations or persons mentioned in Article 5 may become members of this Association on making application, without payment of dues or assessments.

Article 7. The expenses of this Association shall be met annually by a *pro rata* apportionment to all the active County Mosquito Extermination Commissioners in the State.

Article 8. This Constitution may be amended at any regular meeting by a two-thirds vote of the members present.

The present membership is 257.

LARVICIDES

A certain amount of time was given to the testing of various substances as larvicides. In the main the study was limited to such substances of a mineral or organic nature which the cost and recognized properties indicated might form larvicide.

NaCl and $CaCl_2$. The work on these substances confirmed the results obtained by Chidester[1] and showed that the amount necessary (NaCl and $CaCl_2$) was such as to render the use of either impracticable from the standpoint of cost.

NaOH. The resistance of fully-grown larvæ of *A. cantator* and *A. sollicitans* to NaOH was determined by adding it to creek water (2.9 per cent salinity) in doses ranging from 0.0001 gm. to 0.2 gm. per 1,000 c.c. Two-tenths gm. had killed everything in 3 days. Another test, in the course of which tap water was substituted for the creek water, was then set up with amounts of NaOH ranging from 0.5 gm. to 20 gm. per 1,000 c.c. In two days some killing was visible in the 1-gm. solution, more in the 5-gm., and complete killing in the 20-gm. A brown precipitate appeared in all jars from 0.1 gm. up.

Sodium sulfo carbonate. (This is a commercial article and not C. P. It was prepared by the Dow Chemical Co.). It was used in testing the resistance of fully-grown larvæ of *A. cantator* and *A. sollicitans* in tap water to strength ranging from 1 to 3 c.c. of the material to 100 c.c. of water. In two days the larvæ had transformed to pupæ and some adults had emerged.

Borax. (This is marked refined, and furnished by Eimer and Amend.) The resistance of 2 to 4-mm. *C. pipiens* larvæ to borax in tap water, in amounts ranging from 3.5 to 20 gm. to 1,000 c.c., was tested. In the first six days the

[1] Chidester, F. E., N. J. Agr. Exp. Sta. Bul. 299.

larvæ seemed to be quite normal. The charge was then increased so that the amounts ranged from 30 to 50 gm. In two days more everything seemed normal. Two days later the charge was in every case increased to 100 gm. In one day more there were no changes.

Copper sulfate. The resistance of 2 to 4 mm. larvæ of *C. pipiens* to copper sulphate in tap water ranging from 1 to 20 gm. per 1000 c.c. was tested. In one day all in 20 gm. were dead, and most of those in 10 gm. had succumbed. In one day more all in 10 gm. and all in 5 gm. were dead. In one day more all in 1 gm. were dead. The doseage for killing in 48 hours seems to be 5 gm. to 1,000 c.c.

Iron sulfate. (This is the American Steel and Wire product.) The resistance of 2 to 5 mm. larvæ of *A. sollicitans* to iron sulfate in tap water, using amounts ranging from 2.5 to 50 gm. per 1,000 c.c., was tested. Two days later all were dead in the 50-gm. solution, but all in weaker strengths were alive.

Pyrethrum. The resistance of *C. pipiens* larvæ ranging from 3 to 6 mm. in length, by placing amounts ranging from 1 to 10 gm. to 100 c.c. of tap water, was tested. The mixture was allowed to stand over night and 25 specimens placed in each jar the following morning. In one day all were dead in the tested jars. The same process was then repeated by using strengths ranging from 1 gm. to 2,000 c.c. down to 1 gm. to 10,000 c.c. In two days all larvæ were dead. The test was then turned around, and jars in which the larvæ had been placed in tap water were treated with a water extract of pyrethrum at strength ranging from 7 gm. to 3,000 c.c. to 1 gm. to 20,000 c.c. In one day all were dead in the 1 to 2,000 c.c. In two days all were dead in 1 to 3,000. In three days all were dead in 1 to 20,000.

Nicotine. The resistance of 5-mm. larvæ of *A. sollicitans* to 40 per cent nicotine in tap water at strength ranging from 1 c.c. to 1,000 c.c. to 1 c.c. to 40,000 c.c., was tested. In one day all larvæ were dead in 1 to 10,000 or greater. Also, the resistance of 2 to 4 mm. larvæ of *C. pipiens* to nicotine, in tap water, was tested, at strengths varying from 1 c.c. to 30,000 c.c. to 1 c.c. to 60,000 c.c. In 2 days all were dead in 1 to 40,000, and in 4 days all were dead in 1 to 60,000.

Quassia. A water extract of quassia was prepared by macerating 50 gm. of quassia chips in 50 c.c. of distilled water. The resistance of 2 to 4 mm. larvæ of *C. pipiens* to quassia, in tap water varying from 1 c.c. to 1,000 c.c. to 50 c.c. to 1,000 c.c., was tested. In two days all were dead in 50 c.c. to 1,000 c.c. In three days no further killing was visible.

Hellebore. The resistance of 2 to 4 mm. larvæ of *C. pipiens* to hellebore, in strengths ranging from 6 to 40 gm. to 1,000 c.c. of tap water, was tested. Eight hours before the larvæ were introduced, the hellebore was placed in the water and thoroughly mixed with it. In two days all were dead in the 40 to 1,000. In three days a few were dead in the 30 to 1,000. In eight days all were dead.

Ginger. The resistance of 2 to 4 mm. larvæ of *C. pipiens* to ginger, in strength ranging from 0.5 to 5 gm. per 1,000 c.c. tap water, was tested. In 1 day all were dead in 5 to 1,000, and most of the specimens were dead in 2 to 1,000. In two days all were dead.

Pyroligneous acid. (This is the purified product made by the Mallinkodt Chemical Works.) The resistance of 2 to 4 mm. larvæ of *C. pipiens* to pyroligneous acid in tap water at strength varying from 1 c.c. to 1,000 c.c. to 1 c.c. to 40,000 c.c. was tested. At the end of 6 days all were alive. The dose was then increased 1 to 500, and in 2 days later all were alive.

Carbo-sul. This is a commercial preparation. It is an emulsified carbon disulfide. The resistance of fully-grown larvæ and some pupæ of *A. cantator* and *A. sollicitans* to carbo-sul was tested in tap water at strengths varying from 3 c.c. to 100 c.c. to 1 c.c. to 1,000 c.c. In one day all larvæ in 3 to 100 were killed. The pupæ gave up adults which died before they could take wing. The weakest strength killed a few larvæ in 36 hours.

Pyridine. (This is the technical from Eimer and Amend.) The resistance of fully-grown larvæ and some pupæ of *A. cantator, A. sollicitans,* and *C. salanarius* to pyridine in tap water was tested, at strengths varying from 0.00001 c.c. to 1,000 c.c. to 0.2 c.c. to 1,000 c.c. In one day all were dead in 0.2 to 1,000. In two days some were dead in 0.1 to 1,000. In the latter strength some of the pupæ gave up adults which, however, perished before they could take wing.

Cresol. (This is U. S. P. from Eimer and Amend.) The resistance of 2 to 4 mm. *C. pipiens* larvæ to cresol in tap water at strengths varying 1 c.c. to 8,000 c.c. to 1 c.c. to 50,000 c.c. was tested. In one day all were dead in 1 to 30,000 and greater strengths. In two days all were dead in 1 to 50,000.

Lysol. (This is a commercial product manufactured by Leher and Fink.) The resistance of 2 to 4 mm. *C. pipiens* larvæ to lysol in tap water in strengths varying from 1 c.c. to 8,000 c.c. to 1 c.c. to 50,000 c.c. was tested. In one day all were dead in 1 to 40,000.

Phenol. (This is 100 per cent crude carbolic acid furnished by Eimer and Amend.) The resistance of *C. pipiens* larvæ 2 to 4 mm. long to phenol was tested in tap water at strength varying from 1 c.c. to 1,000 c.c. to 1 c.c. to 40,000 c.c. In two days all were dead in 1 to 20,000 and in greater strengths. In four days all were dead in 1 to 30,000.

Mixture of 10 c.c. pyridine, 10 c.c. xylol, and rosin to make 25 c.c. The resistance of 2 to 4 mm. larvæ of *C. pipiens* to this mixture in tap water in strengths varying from 1 c.c. to 20,000 c.c. to 1 c.c. to 50,000 c.c. was tested. In one day all were dead in 1 to 40,000. This experiment was repeated under the same conditions with the same species of larvæ, and in two days all were dead in the 1 to 50,000.

Standard Oil samples. During the winter of 1915 the writer requested the Standard Oil Company to prepare an oil which would give good spreading power with strong staying ability. The company responded with three samples, No. 1 and No. 2 of which were black in color. while No. 3 was a straw yellow. On February 24, 1915, the writer selected three glass dishes, filled to the same height with distilled water. Each dish had about 70 square inches of water surface. Each was treated with 5 c.c. of oil The first received its supply from Sample 1, the second from Sample 2, and the third from Sample 3. Thirty-one days later the oil film of No. 3 was complete, while on both No. 1 and No. 2 it was broken. Three large glass dishes were then prepared, filled to the same height with water, and each made the recipient of 50 or more 2 mm. larvæ of *C. pipiens.* Oil was introduced at the rate of 3 c.c. to the square foot. The first was treated with sample No. 1, the second with No. 2. and the third with No. 3. One day later 8 larvæ were alive in No. 1, 10 in No. 2, and 0 in No. 3.

A test of the lasting power of some of the more promising substances was arranged Seven wooden wash-tubs were arranged in 3 pairs and a check. One series was filled about half full of red shale soil.

It thus appears that none of the mixtures tried in the above experiment persist to a satisfactory extent, and that the best from that standpoint is Standard Oil sample No. 3.

It is easy to find substances that will kill mosquito larvæ very quickly, but to get one that will remain effective over a long period seems attended with difficulties. All tubs were filled to the same height with water The tubs were allowed to stand until larvæ of *C. pipiens* appeared in each.

Pair No. 1 was then treated with a proprietary substance, known as Khan's mixture, at the rate of 10 gms., to the gallon of water. Pair No. 2 was treated with Standard Oil sample No. 3 at the rate of 1.5 c.c. to the gallon. Pair No. 3 with pyridine at the rate of 1.5 c.c. to the gallon. Pair No. 4 with

the mixture pyridine, xylol and rosin at the rate of 1.5 c.c. to the gallon. The tubs were left outdoors throughout the experiment. The results are set forth in Table XV.

Table XV

Results of Experiment with Samples of Oil as Larvicides

DATE	No. 1 Khan's Mixture	No. 2 Standard Oil No. 8	No. 3 Pyridine	No. 4 Pyridin & Xylol & Rosin	No. 5 No Treatment
9/4, ...	Experiment set up.				
9/5, ...	All alive	All alive	All dead except pupae	All dead except pupae	All alive
9/6, ...	Few dead	Few dead	All dead	All dead	All alive
9/7, ...	All dead	All dead	" "	" "	" "
9/10, ...	" "	" "	C. living pipiens present	C. living pipiens present	" "
9/11, ...	" "	" "	" "	" "	" "
9/12, ...	C. living pipiens present	" "	" "	" "	" "
9/13, ...	" "	" "	" "	" "	" "
9/14, ...	" "	C. living pipiens present	" "	" "	" "
9/15, ...	" "	" "	" "	" "	" "

CONCLUSIONS

The four contracts between the State and various contractors for salt-marsh ditching, which were executed but not finished last year, have been satisfactorily completed this year, with a total of 745,105 linear feet of narrow ditching.

The counties have cleaned thoroughly 500,000 linear feet of ditching, and removed obstructions throughout all the drainage systems to keep them in working order. The counties have cut 2,543,713 linear feet of new 10 x 30-inch ditching or its equivalent on the salt marsh. They have patrolled 95,000 acres of salt marsh (covering a coast line of 125 miles), have patrolled 315,000 acres of upland, and have afforded a good measure of protection to one and three-fourths millions of people.

The investigation of larvicides, which included a test of substances consisting of metal salts, drugs and more or less pure organic chemicals, shows that while a number of compounds that would destroy mosquito larvæ were found, none had the ability to remain effective for more than a limited period after the application was made.

REPORT OF
DEPARTMENT OF PLANT PATHOLOGY

Department of Plant Pathology

MELVILLE T. COOK, PH.D., *Plant Pathologist.*

WILLIAM H. MARTIN, A.B., *Research Assistant.*

WEBSTER S. KROUT, M.SC., *Research Assistant.*

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Report of the Department of Plant Pathology

MELVILLE THURSTON COOK

I

ORGANIZATION

The organization of the department is practically the same as last year. Mr. W. H. Martin, B.A., of the University of Maine, and Mr. W. S. Krout, M.S., of the Ohio State University, continue as assistants in both the Experiment Station and the College. The Union Sulphur Company Fellowship, which Dr. H. Clay Lint has held for the last three years, terminated October 1. Mr. G. W. Martin, M.S., former assistant in the department, spent one month during the summer working on the *brown blotch* of the pear. This problem is unfinished, tnd will require at least one more season's work. Mr. C. M. Haenseler, M.S., of the University of Tennessee, has been appointed to the fellowship established by the New Jersey Zinc Company for the study of "Fungi Injurious to Paints." Mr. C. A. Schwarze, M.A., of Columbia University, continues with us as Assistant State Plant Pathologist, and Mr. Edgar L. Dickerson, B.S., of Rutgers College, was employed as special Assistant State Plant Pathologist during July and August to assist in the nursery inspection work. Mr. Ralph B. Lott, of Greenwich, New Jersey, was employed as Special Inspector during November and December of 1915 and March, April and May of 1916.

II

CLIMATIC CONDITIONS

There was more rainfall during the spring and summer than usual. This resulted in a large number of fungus diseases of cultivated crops and a number of calls for personal visits to farms, which it was impossible to meet. The correspondence during the spring and summer was heavier than for the corresponding period for the past four years. During the fall the correspondence was lighter than for the corresponding period of the past four years. It is unfortunate that we are unable to meet this demand for personal visits to farms and that we are unable to conduct demonstrations in control of plant diseases.

III

COOPERATION

Experiments for the control of the common potato scab with sulfur were conducted by Dr. H. Clay Lint on the farms of Mr. Walter Minch, Bridgeton; Mr. M. F. Riley, Elmer; Mr. W. J. MacFarland, Burlington; Mr. Earl Dilatush, Robbinsville, and Mr. J. C. Burtis, Allentown. The results of this work are appended to this report (page 618).

Experiments for the control of foliage diseases of the potato by the use of dust (lead arsenate and sulfur) and Bordeaux mixture were conducted by Dr. H. Clay Lint on the farms of Mr. Edward Winsor, Farmingdale; Mr. John Black, Mt. Holly; Mr. H. Courtney Brown, Jamesburg, and Mr. J. Harry Kandle, Elmer.

Experiments for the control of the diseases of celery were conducted by Mr. W. S. Krout on the farm of Mr. Tunis Drenth, of Oradell, New Jersey. The results of this work are appended to this report (page 584).

Experiments on the control of the diseases of tomatoes were conducted by Mr. W. H. Martin on the farm of Miss Jennie Waddington, at Salem, New Jersey; the New Jersey Agricultural Experiment Station, the Truck Disease Laboratory of the United States Bureau of Plant Industry and the H. J. Heinz Company, coöperating. The results of this work are appended to this report (page 575).

IV

OTHER WORK

In addition to the coöperative work, Dr. Lint and the writer have continued their studies on the influence of diseased seed potatoes on the crop, using seed furnished by the United States Bureau of Plant Industry, the Department of Plant Pathology of the Maine Agricultural Experiment Station, the Department of Plant Pathology of the Vermont Agricultural Experiment Station and seed sent in by growers for examination.

Dr. Henry Clay Lint has made studies on Rhizoctonia.

Mr. W. H. Martin has made studies on the effect of Bordeaux mixture on transpiration, using potted plants of economic importance and abscised leaves. Mr. Martin has also coöperated with Dr. J. W. Shive, plant physiologist of this Station, in studies on transpiration. Mr. Martin and Mr. Schwarze have made studies on sclerotial fungi destructive to ornamental plants. This work is incomplete, but will probably be ready for publication in the near future.

Mr. W. S. Krout has made studies on the diseases of egg-plants and comparative studies on bacterial nodules of alfalfa, nematode galls on alfalfa and other plants. Mr. F. P. Schlatter, B.S., fellow in the Department of Botany, has been making special studies on the distinctive characters and relative importance of the fungus diseases of the cranberry and related plants.

During the spring seed from cabbage, known as "Wisconsin-Hollander No. 8," was received from the Department of Plant Pathology of the Wisconsin Agricultural Experiment Station, where it had been developed and proved resistant to cabbage "yellows." This seed was distributed to several of our growers with request that it be grown and reports made to this department. For various reasons only one grower gave a report, and his farm was afterwards visited by the writer.

The seed had been planted on soil on which cabbage had proved a failure in past years, and ordinary cabbage planted on either side of the plot. The "Wisconsin-Hollander No. 8" gave an almost perfect stand, while nearly all the plants of the ordinary cabbage were dead, and the few living plants were worthless. An examination of the ordinary cabbage showed an abundance of "black rot" and "Rhizoctonia."

The writer and Mr. Schwarze have been working for the past four years on an illustrated publication on "Parasitic Fungi of New Jersey." This has been carried on as a side study, purely incidental to the regular work, and was originally started as an aid in the keeping of accurate data. The first installment of this work is now ready, and will be published in the near future.

V

PLANS FOR 1916-17

The following lines of work are proposed for the coming year:

Studies on the influence of disease on seed potatoes by Dr. Mel. T. Cook and Mr. C. M. Haenseler.

Studies on crown gall by Dr. Cook.

Studies on crown gall and legume galls by Dr. Cook and Mr. W. H. Martin.

Sclerotial diseases by Mr. Martin and C. A. Schwarze.

Studies on mosaic diseases by Mr. Martin.

Studies on club root and nematode galls by Mr. W. S. Krout.

Studies on the diseases of celery by Mr. Krout.

Studies on the influence of fungi on paints by Mr. C. M. Haenseler.

Studies on the diseases of greenhouse plants by Mr. Haenseler.

Studies on the influence of soil sterilization on seeds and seedlings by Mr. John Monteith.

Studies on varieties of beans resistant to anthracnose by Mr. E. J. Owen.

Studies on the brown blotch of the pear by Mr. G. W. Martin.

VI

NURSERY INSPECTION

The nursery inspection work under the State Department of Agriculture has been carried on in accordance with the State law. The coöperation on the part of the nurserymen is very encouraging. The shipments of nursery stock into the State have been inspected as thoroughly as circumstances permitted. Probably the most important development in this work has been the discovery of the blister rust of the white pine in the State. This disease was first discovered in the State in 1911 by the State forester, Mr. Alfred Gaskill, and the planting voluntarily destroyed by the owners. Since that time the writer has found small infections in three nurseries, and in every case the stock was destroyed. During the past spring Mr. Ralph B. Lott made an inspection of the nurseries carrying white and other 5-leaved pine stock, but failed to find the disease. Later in the season the Forest Pathology Laboratory coöperated with the State Department of Agriculture by sending Mr. Paul V. Siggers into the State to make special inspections. Mr. Siggers received special training for this work, and his inspections were exceptionally thorough. In one place he found 48 diseased trees in a planting of 1,650. This planting had been inspected by us, but not within the past two years, owing to the owner not wanting a certificate. The trees were shipped to New Jersey from New York, but probably came originally from Europe, and practically the entire shipment is intact. All the diseased trees were destroyed. On a neighboring private estate 12 trees from the same shipment were found to be diseased, and were destroyed. In one nursery one diseased tree was found in a planting of 200; these had been shipped from Germany several years ago. In another nursery 15 diseased trees were found in a planting of 1,400 trees received from France. In another nursery some 15 or 16 thousand black currants were found to be infected, and the foliage burned.

This is a European disease, which is very destructive to the white and other 5-leaved pines. It was introduced into this country in 1909, but did not gain much headway until 1915, when it spread rapidly throughout some of the New England States and New York. It has also been found in some other States. The fungus has its alternating stage on members of the genus *Ribes* (currants and gooseberries). A full discussion of this disease will be found in Farmers' Bulletin 742, of the United States Department of Agriculture.

VII

EPIDEMICS

Several plant diseases were sufficiently severe to be classed as epidemics. They were:

"Peach yellows" and "little peach," which were much more severe than for many years past. Severe outbreaks occurred in well-kept, apparently healthy, orchards.

The "mosaic" of the tomato was exceptionally severe and, undoubtedly, a great factor in reducing the yield.

The "mosaic" of pepper was very severe, but its importance is not recognized by many growers.

The "mosaic," "leaf roll" and "Rhizoctonia" of the potato were the cause of heavy losses.

The "early blight" of the celery was the cause of heavy losses in the celery-growing localities.

The "fire blight" of the apple and pear was epidemic, but not so severe as in 1915.

Shade Trees

In addition to these epidemics we have received a great many complaints concerning shade trees, the leaves wilting or falling and, in some cases, the trees dying. In some few cases we found fungi or other causes of the troubles, but in most cases failed to find any organism that would account for the condition. The question was the subject of several communications with State Forester Alfred Gaskill. It is our opinion that the condition was, in most cases, due to physiological factors, lack of water or food. Many shade trees are so placed that they suffer from lack of both water and food even though there may be a heavy rainfall.

Fume Injuries

We also had several complaints concerning injuries to vegetation, which are evidently due to fumes from brick kilns and manufacturing establishments. These injuries were always associated with rainfall, which, no doubt, carried the injurious gases downward.

VIII

PUBLICATIONS

The following publications have been issued since our last report:

Circular 50, "Common Diseases of Beans," by Mel. T. Cook.

Circular 51, "Diseases of Grains and Forage Crops," by Mel. T. Cook and J. P. Helyar.

Circular 52, "Common Diseases of the Pear," by G. W. Martin.

Circular 53, "Potato Diseases in New Jersey," by Mel. T. Cook and H. Clay Lint.

Circular 55, "Common Diseases of the Grape," by Mel. T. Cook.

Bulletin 291, "The Influence of the Tannin Content of the Host Plant on Endothia Parasitica and Related Hosts," by Mel. T. Cook and Guy West Wilson.

"Two Interesting Diseases of Greenhouse Tomatoes," by Mel. T. Cook and C. A. Schwarze, in *Phytopathology*, v. 6, p. 364–366, August, 1915.

IX

NEEDS

In my discussion of the needs of the department, I must repeat my statement of last year, that the demands of the farmer for personal inspection of growing crops and the heavy correspondence necessitates the employing of an associate plant pathologist. There is also a very great need for a thoroughly trained man to direct demonstration work. The necessity for a specially trained man to direct such work will be appreciated when we take into consideration the fact that many radically different diseases requiring different treatments go under the same common name among the laity, and that some diseases that cannot be controlled by spraying are likely to appear and confuse and discourage the grower. Furthermore, demonstration work in the control of plant diseases should be followed closely enough to secure accurate data. Since the results vary from year to year in accordance with climatic and other factors, an experimental element is necessarily introduced.

The potato growing industry is of very great importance, and should have the undivided attention of one man. This problem involves seed culture, spraying, etc. The most important factor in this problem is that of disease. The seed carries diseases, some of which cannot be eradicated by treatment, necessitating a long period of experimental work with both northern and home-grown seed. This involves coöperation with the United States Bureau of Plant Industry and the experiment stations of several northern States.

The "mosaic" disease of the tomato and pepper is the cause of heavy losses, and should receive a great deal of attention. Other diseases of the tomato, such as Fusarium wilt, are very threatening, and should receive special attention. The spraying of tomatoes and potatoes needs to be thoroughly tested in different parts of the States. The conditions in this State are so varied that results in one part are not necessarily an index of the results in other parts.

Other diseases that should be investigated are the wilt diseases of the eggplant, wilt and blight diseases of melons and cucumbers, root and leaf diseases of alfalfa and other legumes, diseases of shade trees and diseases of ornamentals.

The Herbarium

Unfortunately our herbarium has been neglected for several years. The mounted plants should be gone over carefully and put in place. Several hundred unmounted plants should be mounted and properly distributed so that they can be used.

X

MOST COMMON DISEASE OF THE YEAR

The following is a list of the diseases collected by members of the staff of this and other departments and sent in by the growers:

Alfalfa

Leaf Spot (*Pseudopeziza medicaginis* (Lib.) Sacc. This disease has been about the same this year as in past years. It is no doubt the cause of much heavier losses than is appreciated by most growers.

White Spot (Cause undetermined). Prevalent but not causing a falling of the leaves. We also find a similar spotting on the clovers.

Leaf Spots (*Pleospora sp.* and *Cercospora medicaginis* E. & E. and *Stagnospora carpathica* Baueml.). Occasional.

Several undetermined leaf spots which may have been incipient stages of some of the above, or due to some other causes, were sent in from time to time. There was also a very severe yellowing or blighting of certain fields throughout the State. This was apparently associated with soil conditions.

Root Gall (*Nematodes*). This trouble was found in a few places, but we are unable to say just how widely distributed or how injurious.

Root Rots (*Thielavia basicola* (B. & Br.) Zopf. *Rhizoctonia.* These rots have been found in a few places, but we are unable to say just how widely distributed or how injurious.

Note.—The diseases of the alfalfa promises to increase in importance. The problem involves the selection of varieties, cultural methods and the study of the diseases. It will necessitate the combined work of the agronomist and the plant pathologist.

Ampelopsis

Leaf Spot (*Phyllosticta ampelopsidis* Ell. & Mart.). This disease was quite common on the lower part of the ivy plants on buildings, and was a very serious pest in the nurseries. It attacks both *A. quinquefolia* and *A. tricuspidata.*

Die Back (*Cladosporium sp.*). This disease occurs on the *A. tricuspidata.* It was much less severe than in 1915. This was probably due to the heavy rainfall throughout the season.

Apple

Jonathan Spot (*Alternaria sp.*). A peculiar spotting of the Jonathan is without doubt due to this organism. It continues to be equally severe from year to year.

Other very similar spots are no doubt due to other causes. The study of these minor apple spot rots is of greater importance than is at first apparent. They no doubt serve as points of infection for other and more serious rot organisms.

Blossom End Rot (*Alternaria sp.*). This disease continues to cause a great deal of trouble with many varieties. It is frequently assocated with the black rot.

Anthracnose, or Bittler Rot (*Glomerella ruformaculans* (Berk.) S. & Von. S.). Several records. More common than usual.

Black Rot (*Sphaeropsis malorum* Pk.). Common and severe on unsprayed orchards.

Fire Blight (*Bacillus amylovorus* (Burr.) De Toni). This disease was less destructive than in 1915. However, it was very abundant in many orchards in the southern half of the State and more severe in the northern half than in 1915.

BLOTCH (*Phyllosticta solitaria* E. & E.). This disease has been very severe on some varieties, specially Smith's Cider, but no more severe than in previous years.

SOOTY BLOTCH (*Phyllachora pomigena* (Schw.) Sacc.). Common in unsprayed orchards.

SCAB (*Venturia pomi* (Mont. & Fr.) Sacc.). This disease was prevalent throughout the State, but did not reach the proportions of an epidemic. One extremely interesting case was where the conidial stage of the organism had wintered on the twig. The possibility of this occurring has been the subject of considerable dispute.

BROWN ROT (*Sclerotinia fructigena* (?) (Per) Schroet.). Occasional.

PINK ROT (*Cephalothecium roseum* Cda.). Common.

LEAF SPOTS (*Phyllosticta pyrina* Sacc.) (*Sphaeropsis malorum* Pk.). Common and about as severe as usual.

RUST (*Gymnosporangium juniperi-virginianae* Schw.). Very common in Cape May County and frequently collected in small quantities in other parts of the State. (*G. globosum* Farl.). Occasional.

CROWN GALL (*Pseudomonas tumefaciens* E. F. Smith & Townsend). This very common disease is receiving more attention from both nurserymen and growers. We have had several reports concerning it.

WATER CORE. Occasional.

SPRAY INJURY. Occasional.

STIPPEN (*Cylindrosporium pomi* Brooks). Two records.

WINTER INJURY. Less common than for several years.

ASPARAGUS

RUST (*Puccinia asparagi* De C.). This disease occurred in various places, but not in sufficient quantity to be of any importance.

ROOT ROT (*Rhizoctonia sp.*). This organism was found to be very destructive in one planting and reports indicate that it may be prevalent in other places.

ASTER

YELLOWS. This disease, which is due to an unknown cause, occurred in many places and was very destructive. We have had a less number of complaints than usual.

ROOT ROT (*Fusarium sp.*). Several records.

AZALEA

GALLS (*Exobasidium vaccinii* Fel. Wor.). Several reports. One very severe case on azaleas in a nursery.

BARLEY

SMUT (*Ustillago nuda* (Jens.) Kell. & Sw.). Very common and in some cases very abundant.

POWDERY MILDEW (*Erysiphe graminis* D. C.). Occasional.

BEANS

ANTHRACNOSE (*Colletotrichum lindemuthianum* (Sacc. & Magn.) Bri. & Cav.). This disease was very abundant, but was less severe than in 1915. It was the cause of many complaints. (Plate I, fig. 1.)

LEAF SPOT (*Phyllosticta phaseolina* Sacc.). This disease was quite common on the leaves of lima beans.

POD SPOT (*Phoma subcircinata* E. & E.). This disease was very common on the lima beans.

DOWNY MILDEW (*Phytophthora phaseoli* Thaxter). Common on the lima bean. Some very severe outbreaks in the southern part of the State following damp, foggy weather.

ROOT ROT (*Rhizoctonia sp.*). This organism is frequently present in cankers on the stems. It was frequently associated with *C. lindemuthianum.*

BEET

LEAF SPOT (*Cercospora beticola* Sacc.). Quite common.

ROOT ROT (*Phoma betae* Frank). This rot has been found in a few cases in both fields and storage.

BLACKBERRY

ANTHRACNOSE (*Gloeosporium venetum* Speg.). Common and destructive in many places.
LEAF SPOT (*Septoria rubi* West.). Common.
RUST *Gymnoconia peckiana* (Howe.) Tranz.) Common and the subject of many inquiries.

CABBAGE, CAULIFLOWER AND KOHLRABI

CLUB ROOT (*Plasmodiophora brassicae* Wor.). This disease was reported from several localities.
BLACK ROT (*Pseudomonas campestris* (Pammel) Smith). Reported frequently, and in most cases very destructive.
DAMPING OFF (*Rhizoctonia* and *Fusarium*). Several reports.

CANTALOUP

See Muskmelon.

CARNATION

RUST (*Uromyces caryophyllinus* (Schrank) Wint.). Common, but not serious.
ROOT ROT (*Rhizoctonia*). Common, but not serious.
YELLOWS (?). Serious on some varieties.

CATALPA

LEAF SPOT (*Macrosparium catalpae* Ell. & Mart.). Common.
LEAF SPOT (*Phyllosticta catalpae* Ell. & Mart.). Common.
Note.—These leaf diseases were accompanied by a falling of the leaves which many people supposed was due to the disease. The spotting was no more severe this year than in previous years, and the falling was probably due to other causes.

CEDAR

RUST (*Gymnosporangium juniperi-virginiana* Schw.). (*Gymnosporangium germinale* (Schw.) Kern). Reported, but of little importance. The former was most abundant in Cape May County. *G. botryapites* was found to be quite abundant in Atlantic County.

CELERY

DAMPING OFF (*Fusarium sp.*). Common in seed-beds.
EARLY BLIGHT (*Cercospora apii* Fr.). Reported from several places. Very destructive.
LATE BLIGHT (*Septoria petroselini* Desm. var. *apii* Br. & Cav.) (Bacterial). Very abundant in certain localities and most important celery disease in the State.
CROWN ROT (Bacterial). Very severe in many localities.
HEART ROT (Bacterial). Very severe in many localities.

CHERRY

BROWN ROT (*Scleratinia fructigena* (Pers.) Schroet). Common.
LEAF SPOT (*Cylindrosporium padi* Karst.). Common and the subject of many complaints.
WINTER INJURY. Several complaints.

CHESTNUT

BARK DISEASE (*Endothia parasitica* (Mur.) Ander.). Common throughout the State.
LEAF SPOT (*Actinopelte japonica* and *Marssonia ochroleuca* B. & C.). Frequent.

CITRON

LEAF SPOT (*Cercospora citrullina* Cke.). Common.

CRIMSON CLOVER

CROWN ROT (*Sclerotinia libertiana* Fuckel). Less frequent than usual.

Red Clover

Rust (*Uromyces trifolii* (Hedw.) Lev.). Occurs throughout the State.
Anthracnose (*Gloeosporium caulivorum* Kirchner). One record.
White Spot (?). Same as on alfalfa.

White Clover

Leaf Spot (*Stagnospora carpathica* Bauml.) One record.

Sweet Clover

Stem Spot (*Ascochyta caulicola* Laubert). One record.

Corn

Smut (*Ustilago zeae* (Beckm.) Ung.). This very common and very widely distributed disease is not often serious except on sweet corn.

Wilt (*Pseudomonas stewarti* Erw. Smith). Very few reports.

Rust (*Puccinia sorghii* Schw.). Not serious.

Leaf Blotch (*Helminthosporium insconspicum* C. & E.). Common. Farmers attribute this to weather.

Cowpea

Leaf Spot (*Cercospora dolichii* E. & E.). Frequent.

Cranberry

Scald (*Guignardia vaccinii* Shear.). This disease was widely distributed throughout the State, and the cause of considerable loss where the bogs were not well sprayed.

Gall (*Synchytrium vaccinii* Thomas). Found on the wild plants growing near commercial bog. *Also found on the blue berries associated with the diseased cranberries.*

False Blossom (Cause undetermined). Found in several bogs. It is known that this disease was brought into the State on plants from Wisconsin, but it is by no means certain that it was not already in the State.

Rot (*Acanthorhynchus vaccinii* Shear). *Abundant where the vines are heavy and* the spraying cannot be done effectively.

Anthracnose (*Glomerella rufomaculans vaccinii* Shear). Gloeosporium stage abundant.

Minor diseases (*Pestalozzia guepini* Shear) on old vines; (*Sporonema oxycocii* Shear) on leaves and berries; (*S. pulvinatum* Shear) on leaves; (*Microsphaeria vaccinii* Shear) on leaves where bogs had been brunt over.

Cucumber

Wilt or Blight (*Bacillus tracheiphilus* Erw. Smith). Very widely distributed and the cause of considerable loss.

Downy Mildew (*Plasmopara cubensis* (B. & C.) Humphrey). Common and frequently the cause of heavy losses.

Leaf Spot (*Macrosporium cucumerinum* E. & E.). Frequent.

Currants

Cane Blight (*Botryosphaeria ribis* G. & D.). Several reports of this disease indicate that it is very destructive on red currants throughout the State.

Leaf Spot (*Septoria ribis* Desm.). Very common.

Rust (*Cronartium ribicola* Kleb.). Found in one place in the State. The Peridermiun stage has been found on the pines in other places. *(See page 564.)*

Dahlias

Leaf Spot (*Phyllosticta sp.*). Common.

Dewberry

Double Blossom (*Fusarium rubi* Wint.). This disease continues with equal severity where the nurserymen and growers do not try to control it. However, many of our most progressive men are keeping it well under control by hand picking of the diseased buds early in the season. It is most severe on Lucretias, Rathbuns and Black Diamonds.

Anthracnose (*Gloeosporium venetum* Speg.). Very abundant and in some cases destructive.

Leaf Spot (*Septoria rubi* West.). Common.

Rust (*Gymnoconia peckiana* (Howe.) Tranz.). Reported as common and in some cases destructive.

Eggplant

Leaf Blight (*Phomopsis vexans* (Sacc. & Syd.) Harter). Very common and in some cases destructive.

Wilt (*Fusarium sp.*) Common and destructive.

Gladiolus

Bulb Rot. Cause undetermined. Several complaints.

Gooseberry

Anthracnose (*Pseudopeziza ribis* Kleb.). Gloeosporium stage has been found in several places.

Leaf Spot (*Septoria ribis* Desm.). Common.

Grape

Black Rot (*Guignardia bidwellii* (Ell.) Viala & Ravaz.). Common and very destructive in many vineyards in the southern part of the State.

Anthracnose or Bird's Eye Rot (*Gloeosporium ampelophagum* Sacc.). Occasional.

Ripe Rot (*Gloeosporium fructigenum* Berk.). Occasional.

Necrosis (*Fusicoccum viticolum* Reddick). Occasional.

Downy Mildew (*Plasmopara viticola* (B. & C.) D. T.). Common but not serious.

Bitter Rot (*Melanconium fuligineum* S. & V.). Occasional. (Plate I, fig. 2.)

Hollyhock

Rust (*Puccinia malvacearum* Mont.). Very common and the subject of many inquiries.

Horse-Chestnut

Leaf Blotch (*Phyllosticta paviae* Besm.). Less severe than usual.

Juniper

Rust or Cedar Apple. See Apple.

Lilac

Mildew (*Microsphaera alni* (Wallr.) Wint.). Abundant throughout the State.

Leaf Spot (*Phyllosticta halstedii* Ell.). Reported from several localities.

Maple

Tar Spot (*Rhytisma acerinum* (P.) Fr.). Occasional.

Leaf Spot (*Phyllosticta acericola* C. & E.). Common.

Anthracnose (*Gloeosporium apocryptum* E. & E.). Several records.

Leaf Scald (Physiological). Many complaints.

Winter Injury. Occasional.

Muskmelon

Wilt or Blight (*Bacillus tracheiphilus* Erw. Smith). Common and destructive in some cases.

Downy Mildew (*Plasmopara cubensis* (B. & C.) Humphrey). Common, but not severe.
Mold (*Cladosporium cucumerinum* Ell. & Arth.). Common.

Nasturtium

Leaf Spot (*Bacterium aptatum* B. & J.). One report.
Root Galls (Nematodes). One record.

Oak

Anthracnose (*Gnomonia veneta* (Sacc. & Speg.) Kelb.). The *Gloeosporium* stage was sent in a few times.
Mildew. Conidial stage.

Oats

Smut (*Ustillago avenae* (Pers.) Jens.). Common.
Rust (*Puccinia coronata* Cda.). Common.
Rust (*Puccinia triticina* Erik.). Common.
Rust (*Puccinia graminis* Pers.). Occasional.

Okra

Wilt (*Verticillium sp.*). Abundant in one locality and found in another.

Pea

Leaf Spot (*Ascochyta pisi* Lib.). Occasional.

Peach

Brown Rot (*Sclerotinia cinerea* (Bon.) Wor.). Common throughout the State. Severe on fruit in unsprayed orchards.
Crown Gall (*Pseudomonas tumefaciens* Erw. Smith and Townsend). Common. See Apple.
Leaf Curl (*Exoascus deformans* (Berk.) Fuckel). Abundant where the orchards were not sprayed.
Scab (*Cladosporium carpophilum* Thüm.). The severity of this very common disease varied with the thoroughness of the spraying.
Shot Hole (*Phyllosticta circumcissa* Cooke). Common.
Shot Hole (*Bacterium pruni* Smith). Much more severe than usual. In some cases caused injuries similar to hailstone injury (Plate II; Plate III, fig. 1, 2).
Powdery Mildew (*Sphaerotheca pannosa* (Wallr.) Lev.). Occasional.
Yellows and Little Peach. Much more severe than usual. Frequently causing heavy losses in well kept orchards which previously were comparatively free of disease.
Winter Injury. Several reports.

Pear

Fire Blight (*Bacillus amylovorus* (Burr.) De Toni). Common. See Apple.
Leaf Blight (*Fabraea maculata* (Lev.) *Entomosporium* stage). Abundant on leaves and fruit. This disease is likely to cause severe losses in good crop years unless the growers give more attention to its control.
Leaf Spot (Septoria pyricola Desm.). Abundant.
Brown Blotch (Cause undetermined). Abundant. Growers report that the treatment recommended in Circular 52 was thoroughly satisfactory.

Peony

Bud Rot (Cause undetermined). Prevalent.

Pepper

Anthracnose (*Colletotrichum nigrum* E. & H.). Common in fall.
Rot (*Macrosporium sp.*). Common on fruits and also found on seeds. May have been secondary.
Mosaic (Cause undetermined). Very severe and the cause of heavy losses (Plate IV, fig. 1).

PINE

ROOT DISEASE. This disease is evidently due to the attack of a root fungus resulting in a *Mycorhiza*. It is very destructive in the nurseries on pines and other coniferous stock grown under crowded conditions.

RUST (*Peridermium piriforme* Pk.). Common in Atlantic County and probably has a wider distribution. The *Cronartium* stage on *Comptoniae* was also collected in Atlantic County.

RUST (*P. acicolum* Und. & Earle). Common in Atlantic County.

RUST (*P. pini*). Was also collected in Atlantic County on *Pinus taedes*.

RUST (*P. strobi* Kleb.). The much feared European blister rust has been found in four localities in the State. Every possible effort is being made to eradicate it. (See rust on currant, p. 570, and also on p. 564.)

POPLAR

LEAF SPOT (*Marsonia populi* (Lib.) Sacc.). Common.

CANKER (*Dothichiza populea* S. & B.). Several reports of this disease were sufficiently urgent to necessitate special investigation. The disease was found to be very severe and destructive (Plate V, fig. 2).

POTATO

SCURF (*Rhizoctonia* or *Corticium vagum* D. & C. var. *solani* Burt.). This very widely distributed disease was almost as severe as in 1915.

BLACK LEG (*Bacillus phytophthorus* Appel). This well known disease was less severe than usual.

SCAB (*Actinomyces chromogenus* Gast.). This disease was fully as severe as in past years.

RUSSET SCAB. A peculiar russeting was common in many parts of the State. It appears that this condition can be produced by the common scab organism or by *Rhizoctonia*.

EARLY BLIGHT (*Alternaria solani* (E. & M.) S. & G.). This disease was more abundant, but it cannot be said to be of much importance in the New Jersey crop. It is more important on the late than on the early crops (Plate IV, fig. 2).

LATE BLIGHT (*Phytophthora infestans* De By.). This disease was not reported, but probably occurred in the mountainous districts.

ARSENICAL POISONING was reported from a few localities. It was always due to careless treatment.

TIP BURN. Very common, but there was less complaint this year than usual.

ROLL LEAF (Cause unknown). This disease was much more severe than usual.

MOSAIC (Cause unknown). Prevalent in some fields.

CURLY DWARF (Cause unknown). Frequent.

DODDER (*Cuscuta sp.*). Occasional.

PHLOX

POWDERY MILDEW (*Erysiphe communis* (Walh.) Schl.). Common.

PRIVET

ANTHRACNOSE (*Gloeosporium cingulatum* (Atk.) S. & S.). Several records. In one case killed a large number of cuttings.

PLUM

BLACK KNOT (*Plowrightia morbosa* (Schw.) Thum.). Common throughout the State.

BROWN ROT (*Sclerotinia cinerea* (Bon.) Wor.). Common throughout the State.

SHOT HOLE (*Phyllosticta circumscissa* Cke.). Occasional.

LITTLE PLUM (Cause undetermined). Occasional.

QUINCE

BLACK ROT (*Sphaeropsis malorum* Pk.). Very abundant and very severe. See Apple.

FIRE BLIGHT (*Bacillus amylovorus* (Burr.) De Toni). Abundant and severe. See Apple.

RUST (*Roestelia aurantica* Peck). Occasional.

Raspberry

Anthracnose (*Gloeosporium venetum* Speg.). Abundant and destructive.

Crown Gall (*Pseudomonas tumefaciens* Erw. Smith & Townsend). Abundant. See Apple.

Leaf Spot (*Septoria rubi* West.). Abundant.

Cane Blight (*Coniothyrium fuckelii* Sacc.). Very abundant and destructive. The cause of an increasing number of complaints.

Spur Blight (*Glomerella rubicola* (Ston.) E. & E.). One report.

Rose

Crown Gall (*Pseudomonas tumefaciens* Erw. Smith & Townsend). Frequent.

Anthracnose (*Gloeosporium rosae* Hals.). Common, but not serious.

Leaf Blotch (*Actinonema rosae* (Lib.) Fr.). Common and very severe in the greenhouse.

Powdery Mildew (*Sphaerotheca pannosa* (Wallr.) Lev.) Common, and more severe than usual.

Leaf Spot (*Phyllosticta rosicola* Massal.). Abundant and frequently confused with black spot.

Cane Blight (*Coniothyrium fuckelii* Sacc.). Common and the cause of many complaints.

Snapdragon

Anthracnose (*Colletotrichum anthirrhini* Stew.). Occasional.

Rust (*Puccinia anthirrhini* D. & H.). Two records.

Stem Rot (*Sclerotium*). One record. Very destructive.

Squash

Mosaic (Cause undetermined). One record. A peculiar mottling of the leaves, characteristic of the disease on other plants. No insects present.

Strawberry

Leaf Spot (*Mycosphaerella fragariae* (Tul.) Lindau). Common.

Leaf Spot (*Ramularia tulasnei* Sacc.). Common.

Leaf Spot (*Marsonia potentillae* (Desm.) Fisk). Frequent.

Winter Injury. Frequent.

Powdery Mildew (*Sphaerotheca humuli* (D. & C.) Burr.). One report Very destructive.

Sweet Potato

Black Rot (*Sphaeronema fimbriatum* (E. & H.) Sacc.). Abundant, but not so severe as in 1915.

Wet Rot (*Rhizopus nigricans* Ehr.). Common in storage, but readily controlled by ventilation.

Stem Rot or Yellow Rot (*Fusarium batatatis* Wollen). Common, but not so destructive as in 1912.

Rot (*Diaporthe batatatis* Harter & Field). The Phoma stage. Common.

Charcoal Rot (*Sclerotium bataticola* Taub.). Frequent.

Rot (*Trichoderma koenigii* Ould.). Common.

Rot (*Melanospora globosa* Berl.). Common. May have been secondary.

Rot (*Penicillium sp.*). Common. May have been secondary.

Scurf or Soil Stain (*Monilochaetes infuscans* E. & H.), Common.

Sycamore

Anthracnose (*Gnomonia veneta* (Sacc. & Speg.) Kleb.). Very abundant.

Tobacco

Mosaic (Cause undetermined). One record.

TOMATOES

ANTHRACNOSE (*Colletotrichum phomoides* (Sacc.) Chester). A few reports.
FRUIT ROT (*Macrosporium solani* (E. & M.). Abundant.
STEM BLIGHT (*Fusarium lycopersici* Sacc.). Common and very severe in some localities.
BLOSSOM END ROT (Cause questionable). Common.
LEAF SPOT (*Septoria lycopersici* Speg.). Abundant and very severe in some localities.
MOSAIC—Filiform Leaf (Cause undetermined). Very abundant in many localities. No doubt the cause of heavy losses.

WALNUT

LEAF SPOT (*Marsonia juglandis* (Lib.) Sacc.). Abundant.
YELLOWS (Cause undetermined). Two records.

WATERMELON

ANTHRACNOSE (*Colletotrichum lagenarium* (Pass.) E. & H.). Abundant in southern part of the State.

WHEAT

RUST (*Puccinia coronata* Cda.). Common. (*Puccinia graminis* Pers.). Common. (*Puccinia rubigo-vera* (DeC.) Wint.). Common. *Puccinia triticina* Errh.). Common.
SMUT (*Tilletia foetens* (B. & C.) Trel.). Frequent. (*Tilletia tritici* (Bei.) Wint.). Abundant.
SMUT (*Ustillago tritici* (Pers.) Jens.). Common.
MOLD (*Cladosporium herbarum* (Pers.) Lk.). Occasional.

WILLOW

LEAF SPOT (*Gloeosporium salicis* West.). Common.

Many other diseases on ornamental and on cultivated plants were found and recorded which are not included in the preceding list. Some of them will be described in the "Parasitic Fungi of New Jersey."

XI

TOMATO SPRAYING EXPERIMENTS AT SALEM, NEW JERSEY

WILLIAM H. MARTIN

Introduction

The importance of the tomato-growing industry in New Jersey, and the losses resulting from attacks by fungous diseases, has led the Department of Plant Pathology to conduct experiments for the control of these diseases. While numerous parasitic fungi attack the tomato, comparatively few do much damage in this State. The disease most widely distributed and causing the most serious losses is the late blight. This disease is caused by the fungus *Septoria lycopersici*, Speg. It is difficult to estimate the losses resulting from attacks of this fungus, but in this State it probably does more damage than all the other diseases of the tomato.

The disease was first reported for the United States by Dr. B. D. Halsted from this State (1896–'97). Since then it has become common wherever tomatoes are grown. It is known by various names in different sections of the country, but in New Jersey it is usually termed "late blight" to dis-

tinguish it from the less serious "early blight" (*Macrosporium solani* E. & M.).

The disease is commonly found on the leaf and stem, but it also appears on the calyx, and is reported by Norton[1] as doing damage to the fruit. In New Jersey, however, the injury to the fruit is negligible. On the stem and leaf the disease does its greatest damage. On the leaf the disease first appears as small water-soaked spots; these spots gradually enlarge to about a quarter of an inch in diameter and usually become circular or oval in outline. The mature spots are greyish-white in color, and, in many instances, have a distinct purplish border. Very frequently the spots may coalesce and the entire leaf will present a dead appearance. It is characteristic of the disease that these dead leaves remain attached to the plant. The disease usually attacks the leaves at the base of the plant and works toward the tip of the stem, only a few green leaves remaining at the apex of the branches in advanced stages.

On the stem elongated spots appear; these are not as well defined as the spots in the leaves, but are quite prominent. While the disease does not do as much damage on the stem as it does on the leaves, it is serious, in that the spots on the stem may serve as infection centers.

The disease is favored by moist weather, and under favorable conditions it progresses rapidly, spreading over a field in a short time.

Field Tests

During the summer of 1916 experiments were conducted on the farm of Miss Jennie Waddington, near Salem, New Jersey. The work was done in coöperation with the Office of the Cotton, Truck and Forage Disease Investigation of the United States Bureau of Plant Industry, and the H. J. Heinz Company, of Pittsburgh, Pa.

The experiment was designed to determine (1) to what extent late blight could be controlled by spraying with Bordeaux mixture: (2) the best strength Bordeaux mixture to be used, and (3) the proper time to make the applications. It was not expected that answers to all these questions could be obtained in a single season, but it is hoped that these experiments will be continued for a sufficiently long period to get accurate results, that is, to eliminate as far as possible the differences resulting from variations existing in climatic conditions of various seasons.

The plants used in this experiment were of the "Trophy" variety. The low yields, as will be brought out later, may be attributed to several causes. Shortly after the plants were set in the field a large number were completely defoliated by potato bugs, others wilted and died before they could become established. This necessitated the resetting of a large portion of the field, and as a result the plants were three weeks late in getting started. Another factor that was partly responsible for the low yield was a severe hailstorm at the time the fruit was setting.

Three strengths of Bordeaux mixture were used in this work: (1) 4 pounds of copper sulfate and 4 pounds of lime to 50 gallons of water; (2)

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[1] Norton, J. B. S., Tomato Diseases, Md. Agr. Exp. Sta. Bul., pp. 102–114, 1914.

2 pounds of copper sulfate, 3 pounds of lime to 50 gallons of water: (3) 6 pounds of copper sulfate, 4 pounds of lime to 50 gallons of water. In all there were seven different treatments, as follows:

Plot I. One application of the 2-3-50 Bordeaux mixture in the seed-bed and 5 applications of the 4-4-50 formula in the field on the following dates, June 23, July 6, July 18, August 7 and August 21.

Plot II. Sprayed with 4-4-50 Bordeaux mixture June 23, July 6, July 18, August 7 and August 21.

Plot III. Sprayed with the 4-4-50 Bordeaux mixture, July 18, August 7 and August 21.

Plot IV. Sprayed with the 4-4-50 Bordeaux mixture July 6, July 18, August 7 and August 21.

Plot V. Sprayed with the 2-3-50 Bordeaux mixture June 23, July 6, August 7 and August 21.

Plot VI. Sprayed with the 6-4-50 Bordeaux mixture June 23, July 6, August 7 and August 21.

Plot VII. Sprayed with the 4-4-50 Bordeaux mixture June 23, July 6, July 18 and August 7.

It was intended to spray Plots V and VI on the same dates as Plots I and II, but this was made impossible by a break in the spray engine and the July 18 spray was necessarily omitted. This also accounts for the long interval between the third and fourth application in the other plots.

In plot work it is recognized a necessity to control as much as possible the differences resulting from soil variation. This can be done only by a sufficient number of repetitions and by the use of check plots. In this work there were three repetitions of each treatment. The arrangement of the plots was as follows: A check, two treatments and a check. This was continued throughout a series and the series was repeated three times. This arrangement gave 12 check plots and 21 spray plots, or 33 plots in all. In order that the spraying be done on a commercial scale each of the 21 spray plots was made a little more than one-fourth of an acre in size. In getting the yields it was found necessary to reduce the size of the plots to one-eighteenth of an acre. The plants were set 4 x 4 feet, so that each plot, as harvested, consisted of 150 plants. The general plan was to make each plot 5 rows wide for spraying and take yields from the three middle rows, the two outer rows being used as buffer rows, and as such were discarded.

Table I gives the arrangement of the plots as they occurred in the field. It must be remembered, however, that the three series were continuous, that is, extended the length of the field and were not divided into sections as indicated in the table.

This table also gives the yield in tons per acre from each plot. It will be noticed that in different sections of the experimental area, plots having the same treatment vary considerably. This cannot be avoided for soil variations are certain to occur in an experiment extending over so great an area. By repeating a treatment and its check three times the difference resulting from the average will give a fairly accurate measure of the benefit derived from the treatment in question.

Table I

Arrangement of Plots in Tomato-Spraying Experiment, with Yield Per Acre for Each Plot

Plot	Treatment	Yield Per A, Tons	Plot	Treatment	Yield Per A, Tons	Plot	Treatment	Yield Per A, Tons
1	Check, ...	2.814	12	4-4-50, ... Seed-bed Aug. 21	5.521	23	4-4-50, ... Seed-bed Aug. 21	4.624
2	4-4-50, ... Seed-bed Aug. 21	4.588	13	Check, ...	2.941	24	4-4-50, ... June 23 Aug. 21	4.135
3	4-4-50, ... June 23 Aug. 21	4.706	14	4-4-50, ... June 23 Aug. 21	5.104	25	Check, ...	2.543
4	Check, ...	3.670	15	4-4-50, ... July 18 Aug. 21	4.000	26	4-4-50, ... July 18 Aug. 21	3.303
5	4-4-50, ... July 18 Aug. 21	5.493	16	Check, ...	2.787	27	4-4-50, ... July 18 Aug. 21	3.356
6	4-4-50, ... July 6 Aug. 21	4.724	17	4-4-50, ... July 6 Aug. 21	4.316	28	Check, ...	2.624
7	Check, ...	3.755	18	2-3-50, ... June 23 Aug. 21	3.855	29	2-3-50, ... June 23 Aug. 21	3.665
8	2-3-50, ... June 23 Aug. 21	5.502	19	Check, ...	2.841	30	6-4-50, ... June 23 Aug. 21	4.316
9	6-4-50, ...	5.710	20	6-4-50, ... June 23 Aug. 21	4.163	31	Check, ...	3.402
10	Check, ...	4.172	21	4-4-50, ... June 23 Aug. 7	4.108	32	4-4-50, ... June 23 Aug. 7	4.766
11	4-4-50, ... June 23 Aug. 21	5.927	22	Check, ...	2.507	33	Check, ...	3.122

Manner of Application of the Spray

For this work a gasoline power sprayer was used. This was furnished by the Cotton, Truck and Forage Disease Laboratory of the United States Bureau of Plant Industry. The outfit was a two-wheel, two-horse cart with a 100-gallon tank. It carried two lines of hose each 25 feet long and each hose was equipped with a 5-foot iron extension rod. Each rod was fitted with a single nozzle. Each extension was provided with a cut-off valve at the

base, so that in case the nozzle became clogged, the spray could be shut off without stopping the engine. A pressure of approximately 150 pounds to the square inch was maintained. This gave a fine mist that proved very satisfactory. The spray was applied at the rate of 100 gallons to the acre. This was found to be sufficient to cover each plant thoroughly and evenly.

Table II

Relation of Spraying to Yield and Profit

Plot No.	Treatment With Adjacent Checks	Yield Per Acre, Average of 3 Repeats		Increase Due to Treatment		Cost of Spraying, Per Acre	Value of Increased Ripe Fruit	Net Profit Per Acre	Cost of Spraying with $Cu SO_4$ at Normal Price	Net Profit Normal Year
		Ripe Fruit Tons	Green Fruit Tons	Ripe Fruit Tons	Green Fruit Tons					
	Check, ...	2.784	.060	......	......	......	......	......	......	......
1	4-4-50, Seed-bed, June 23, July 6, 18, Aug. 7, 21, ...	4.911	.349	2.127	.289	$13.77	$21.27	$7.50	$7.77	$13.50
2	4-4-50, June 23, July 6, 18, Aug. 7, 21, ..	4.648	.228	1.597	.147	13.77	15.97	2.20	7.77	8.20
	Check, ...	3.051	.081	......	......	......	......	......	......	......
	Check, ...	3.000	.099	......	......	......	......	......	......	......
3	4-4-50, July 18, Aug. 7, 21, ...	4.265	.302	1.265	.203	8.25	12.65	4.40	4.65	8.00
4	4-4-50, July 6, 18, Aug. 7, 21, ...	4.124	.301	1.069	.199	11.17	10.69	0.48	6.20	4.49
	Check, ...	3.055	.102	......	......	......	......	......	......	......
	Check, ...	3.066	.085	......	......	......	......	......	......	......
5	2-3-50, June 23, July 6, Aug. 7, 21, ...	4.340	.244	1.274	.159	7.53	12.74	5.21	5.04	7.70
6	6-4-50, June 23, July 6, Aug. 7, 21, ...	4.729	.247	1.248	.142	14.69	12.48	2.21	7.36	5.12
	Check, ...	3.481	.105	......	......	......	......	......	......	......
	Check, ...	3.283	.105	......	......	......	......	......	......	......
7	4-4-50, June 23, July 6, 18, Aug. 7, ...	4.822	.358	1.539	.253	11.17	15.39	4.22	6.20	9.19

The spray plots were arranged in such a way that there was a roadway between each two treatments. The spray machine was driven over the same row each time and in the same direction to keep an open alley. The five rows on each side of the roadway constituting a plot.

This method of spraying proved very satisfactory. Little, if any, more time is taken to spray with an outfit of this kind than with the ordinary traction or gasoline power sprayer. More labor is required as one man is needed to drive and two men are required to spray, one man on each side

of the spray machine. The length of the hose enables each man to spray 5 rows on each trip through the field. This, with the row that is driven over, makes 11 rows in all. By this method, with careful operators, both surfaces of every leaf are covered with a film of the mixture; another advantage in favor of the method is the fact that to spray 11 rows it is necessary to drive over but one. This row was discarded in obtaining yields, as well as the two outside rows of each plot, as was previously indicated.

The data secured from the experiment at Salem are tabulated in Table II. It will be noted that the yield of green fruit is greater in the sprayed plots than in the unsprayed plots. This is not thought to be due to the spray but is attributed to the late start made by the plants. This increased green fruit only tends to show that the sprayed vines remained vigorous for a longer period than the unsprayed vines. In calculating the value of the increase from the sprayed plots the green fruit was not included.

A study of Table II shows at once that the first plot, namely, the one receiving one application in the seed-bed, gave the highest returns. There was an increase of 2.127 tons of ripe fruit and 0.349 tons of green fruit over the adjoining checks. It must be noted in this connection that the average of the check plots, 2.739 tons, is well below the average yield. However, it is safe to assume that with a normal yield, while the per cent increase would not have been so large, the difference would have been more striking. While this treatment was not wholly successful in combatting the blight, the plants presented a better appearance than those of the adjoining checks.

While there was an increase of 75 per cent over the check plots, the net returns are not as great as they would be under normal conditions. The price of copper sulfate was 300 per cent higher than normal and this nearly doubled the cost of spraying. The following table gives the cost of making 5 applications of 4-40-50 Bordeaux mixture at the rate of 100 gallons to the acre.

500 gal. Bordeaux mixture @ $1.80 gal.,	$9.00
815 min. (horse) @ 15c per hr.,	2.00
815 min. (man) @ 17.5c. per hr.,	2.36
Depreciation of outfit,	.25
Gasoline,	.16
Total,	$13.77

This includes all the time occupied in preparing the stock solutions, filling the spray tanks and driving to and from the field.

In estimating the cost of this treatment no account has been taken of the cost of the one application in the seed-bed. This, however, is so small as to be considered negligible.

The value of the increase from spraying is estimated in the basis of $10 a ton, this being the price paid by canneries. At this rate the value of the increase is $21.27, giving a net return of $7.50 an acre.

Plot II. In this plot the application in the seed-bed was omitted, the plants were sprayed in the field with the 4-4-50 mixture on the same dates

as Plot I. The increase resulting from the treatment was 1.597 tons of ripe fruit and 0.147 tons of green fruit. The net returns were $2.20 an acre.

Plot III was also sprayed with the 4-4-50 mixture, the applications on June 23 and July 6 being omitted. The increase of 1.265 tons of ripe fruit and 0.203 tons of green fruit is below the average from Plots I and II. The net return from this plot was $4.40 an acre. This increase over the returns from Plot II is explained by the lessened cost of applying the three sprays.

Plot IV was sprayed 4 times with the 4-4-50 mixture, the spray of June 13 being omitted. The increase is not as large as that noted for Plot III, but it is approximately the same, being well within the experimental error. The value of the increase was 10.69 cents. A loss of 48 cents an acre resulted from this treatment.

Plot V was sprayed with the 2-3-50 Bordeaux mixture on the same dates as Plots I and II, with the exception that the spray on July 18 was omitted. This was made necessary by a break in the spray engine. The increase from this treatment was slightly larger than that from either Plots III or IV. An increase of 1.279 tons of ripe fruit and 0.159 tons of green fruit was obtained. The net returns, $5.21 an acre, were greater than from any of the treatments with the exception of Plot I. This may be accounted for by the low cost of the 2-3-50 mixture.

Plot VI. The plot was sprayed with the 6-4-50 mixture on the same dates as Plot V. The increase was about the same for both plots, but there was a loss of $2.20 per acre due to the greater cost of the 6-4-50 mixture.

Plot VII. This plot was also sprayed with the 4-4-50 mixture. The dates of the application were the same as for Plots I and II, with the exception of the spray on August 21, which was omitted. The increase of this treatment over its adjacent checks was 1.539 tons of ripe fruit and 0.253 tons of green fruit per acre with net returns of $4.22 per acre.

Summary

While none of the sprays experimented with gave very complete control of the late blight, it will be seen from Table II that in every treated plot, Bordeaux mixture gave increased returns, regardless of the time of application or the strength of the spray. The check plots were seriously affected with the late blight, while the sprayed plots were less seriously affected and presented a better appearance throughout the season. The plants that were sprayed in the seed-bed made a much more vigorous start than any of the unsprayed plants. This cannot be said to be due to the control of disease, as there was little present in the unsprayed plants so early in the season. The presence of the spray, of course, protected the young plants from insect attack, for while Bordeaux mixture is not an insecticide, the spray acts as a repellant to insects.

From the present season's work it would appear that the most desirable spray mixture is the 4-4-50. It is worthy of note in this connection that

four applications of the 2-3-50 spray gave almost as large returns as five applications of the 4-4-50 mixture. The 2-3-50 formula would be highly desirable if it would serve to protect the plant from fungus attacks for several reasons. (1) This low strength mixture would eliminate any possible spray injury to the plants. (2) The low cost of the materials in the spray is a big factor in its favor. More work, however, must be done before its adoption can be recommended. For the present, it appears that the 4-4-50 mixture could be expected to give best results.

While no definite time of applying the spray can be stated from the data secured, the results tend to favor the early applications. In considering the 4-4-50 treatments they might well be divided into two classes, those receiving early and those receiving late applications. That is, three plots received the first application on June 23, while the other two were first sprayed in July 6 and July 18, respectively. Those receiving the earlier applications gave increased returns of 57 per cent over the adjoining check plots, while the two plots receiving the later treatment gave an increase of 38 per cent over the checks. This shows a 19 per cent increase in favor of the early applications. As has been pointed out the plot receiving one application in the seed-bed gave best returns, there being an increase of 73 per cent over its checks. This is an increase of 21 per cent over the plot that received five applications of the 4-4-50 treatment in the field on the same dates as the former plot. It appears, therefore, from the increased yields from the plots having the early applications that the ideal treatment would be to spray at least once in the seed-bed, though every week would be more desirable, and to make applications in the field at intervals of 10 days or 2 weeks, beginning as soon as the plants are established.

The good results with spraying do not stop with an increased yield. The fruit from sprayed vines is a much better color and more solid than fruit from similar unsprayed vines. These two qualities are highly desirable for cannery tomatoes.

Some of the growers for early market have raised the question as to the influence, if any, the spray has in the ripening period. The results secured throw no light on this question as far as the early market is concerned, but there is little doubt that spraying has little, if any, influence on the time of ripening of tomatoes for the late market or the cannery. This is shown in figure 1. Here the abscissas are taken arbitrarily to represent the dates of picking and the ordinates represent the pounds per acre from each picking. As is shown in figure 1, there result two graphs, the upper one representing the yields from the sprayed vines and the lower the yields from the unsprayed vines.

From figure 1 it is at once clear that there was no difference in the ripening period of the fruit from sprayed and unsprayed vines. The only points the graphs tend to diverge are towards the end of the season when the graph representing the yield from the sprayed vines is uniformily higher. This is to be expected since the vitality of the sprayed vines was, no doubt, prolonged, due to the protection afforded them from fungous attacks.

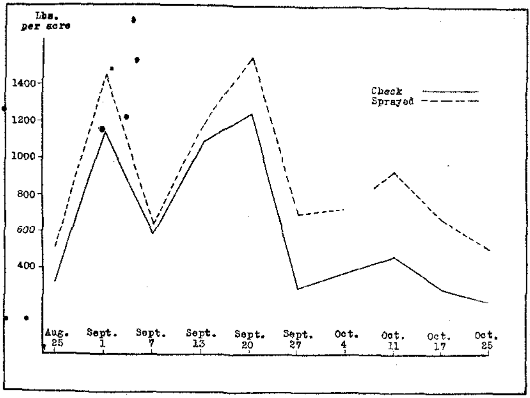

Fig. 1.—Curves showing yields of tomatoes in spraying experiments.

Conclusions

The following conclusions are tentative only, being based on but one year's work.

1. While the sprays employed did not give complete control of the blight, the increased returns will warrant spraying.
2. The 4-4-50 mixture gave best results.
3. The 2-3-50 gave good results and is worthy of further trial.
4. The high cost of the 6-4-50 mixture probibits its use.
5. The best time of application is one or more treatments in the seed-bed, followed by applications every week or 10 days in the field.
6. The present work would indicate that the early sprays are the most important.
7. The fruit from sprayed plants was a better color and firmer than that from similar unsprayed vines.
8. Spraying has no influence on the ripening period.
9. The sprayed plants remained vigorous for a longer period than the unsprayed.

XII

REPORT ON DISEASES OF CELERY

W. S. Krout

Foreword

The following report covers the field work done by the New Jersey Agricultural Experiment Station on the principal celery diseases of the State. All the work was conducted on the farms of Tunis Drenth, Ernest Spell, Drenth Bros., and Henry Kuiper, in the Oradell-Ridgewood celery region in Bergen County, with the exception of a few spray experiments conducted on Mr. Charles Hillman's farm, near Paterson; on Mr. James Nelson's farm near New Brunswick; and on the New Jersey Agricultural Experiment Station farm. The work covers the time between August, 1915, and November, 1916. All data are based on the work done in the Oradell-Ridgewood celery region unless otherwise specified.

Until about fifteen years ago this region was practically unknown to the celery grower. At that time some of the Holland celery growers of the Great Meadow celery region in Warren County discovered this acre of diamonds in the celery world, which was then a primitive peat bog covered with a flora characteristic of its kind, and made investments in it.

The writer wishes to express his thanks to Dr. Mel. T. Cook, in whose department the work was done, to Dr. J. G. Lipman, Director of the New Jersey Agricultural Experiment Station, and to Prof. A. W. Blair, for the many helpful suggestions received during the work. Also, much credit is due Mr. L. F. Merrill, the Bergen County farm demonstrator, for making arrangements with the farmers whereby the work was made possible, and for other coöperation.

Laboratory work is being done upon each of the organisms mentioned in this article, and will be discussed later in another publication.

Objects

The object of the experiments may be briefly summarized as follows:

(1) A safe, simple and economical way of destroying diseases of the greenhouse injurious to celery seedlings.

(2) A control of the *crown rot* disease by the application of various chemicals and field steam sterilization.

(3) Spraying for *early* and *late blight* of celery under which the following points were considered: (a) the cheapest and most efficient spray material to use; (b) the proper strength of each material; (c) how to make and prepare the spray economically, rapidly, accurately and efficiently; (d) weather conditions in relation to the frequency of spraying; (e) the proper time to begin spraying for each disease.

(4) Factors involved in the spreading of the blight organisms from plant to plant and from field to field, and the wintering of the organism.

I. Prevailing Conditions of the Region

Acreage—The acreage is not large at present; only about 300 acres are under actual cultivation; from 400 to 500 acres more are possible. Many companies and individuals are now actively at work bringing this land under cultivation.

Soil—The soil is of peat origin and varies in depth from 9 feet on the east and west sides to 29 feet near the middle. A heavy turf, which covers the surface of all primitive soil, must be removed before cultivation is possible; generally 2 to 4 years is necessary before celery can be expected to produce a maximum crop.

Land Prices—To bring an acre of this peat bog into production costs between $175.00 and $300.00. As a result, improved land sells at $500.00 to $1,000.00 per acre.

Water Table—The region has an ideal water supply as two never-failing brooks run through the middle of the acreage. By letting out or damming up the water in these brooks the water table can be lowered or raised in the most of the fields. Thus in a drought, celery flourishes here while it is firing on the uplands.

Climate and Weather—The climate is typical of the temperate zone with the exception of an excess of moisture. From July 1 to October 1 heavy fogs occur during the night and extend far into the forenoon of each day.

Rains are frequent throughout the summer. The winds are variable, but are usually from the west.

Rotation—Rotation of crops is seldom practiced unless the soil becomes infected with some organism. A rotation of celery for one year and corn for two years; celery, clover and onions; lettuce and celery has been tried upon soil infected with crown rot trouble. None of these rotations gave any relief.

Chemical Relation of the Soil—This soil being of a peat origin is naturally very acid in reaction to litmus. Very little lime has been applied by most of the growers. One grower, who made a limited application this spring to a small acreage, increased his crop approximately 7-5. To avoid injury to the soil by oxidation, chemical determinations are being made to ascertain just how much lime is needed. Studies indicate that from 1,500 to 2,000 pounds of air-slaked lime, $Ca(OH)_2$, might safely be added per acre without detrimental results. However, larger quantities of ground limestone or ground oyster-shell may be added.

Potash is another limiting factor. None was applied to the soil, aside from the plots, during the past year except what came in through organic manures.

The Station has three 1-96 acre plots to which potash was applied at the rate of 1,000 pounds per acre. They all showed increased yields. With this apparent increased production due to the use of lime and potash, the growers and the Station are planning a more extensive series of experiments for the following year both as to the effect of these fertilizers combined and separately. The aim is to increase the vitality of the plants and thus increase its resistance to the organisms of disease.

Celery Culture—The cultural methods of this region are among the most intense on record for celery as three crops are grown throughout the year. Seedlings are grown in hothouses for the first crop, and set in the field from April 7 to May 10, or as soon as the soil is workable. The rows for the first crop are planted from 20 to 30 inches apart. From June 9 to 25 the second crop is planted between the first crop rows. The first crop is harvested from June 20 to July 10, and a third crop planted in every other row that was harvested. The third crop is harvested anywhere from October 1 to January 1. All blanching is by means of boards except with the last crop, which is blanched by earth.

II. Hothouse Experiments

Celery seedlings are very delicate and extremely difficult to grow in the hothouse unless the best of care is given them. One of the most important factors in their growth is the soil. Every grower knows that it takes from 2 to 3 years of consistent work to develop what is considered a good seed-bed soil. Generally, by the time he has this soil improved to the desired tilth, parasitic enemies, such as bacteria and fungi, appear in such numbers as to destroy the plants. Houses were found in which the soil had not been changed since they were first constructed some three to six years ago. The method of replenishing the soil is by the use of organic manures and commercial fertilizers.

Troubles of Houses Previous to Beginning of the Work—This method of handling the seed-bed led to infection. The main trouble was a yellowing of the young plants, similar to that of the crown rot which will be described later. Any time after the production of the fifth leaf the seedling was subject to attack. The symptoms were as follows:

At first a slight yellowing on one side of the seedling. Two to four weeks later the entire plant would be yellow or dead. Only a bacterium species and fusarium species could be isolated from these plants by the sterile tissue method. "Damping off" gave some trouble, but was not serious.

Two of these hothouses which had the above-mentioned troubles, one (No. 1) on the farm of Tunis Drenth, and the other (No. 2) on the farm of Ernest Spell, were taken over by the Station and treated as explained in the following paragraphs:

Cleaning, Spraying and Changing of Soil in Hothouse No. 1—The work was started in this house November, 1915, by emptying and sweeping out all the beds except an 8-foot end of a 3-foot side bed which was left for for formalin treatment. Then the house was sprayed with a 5-6-50 Bordeaux mixture. This was carefully done so as not to leave a square inch of the inside of the house untouched by the spray. The house was closed for two weeks. Two-tenths of a pound of burnt limestone to the cubic foot of soil was then thoroughly worked through this seed-bed soil.

Formalin Plots—Twenty-four square feet (previously referred to) of the old contaminated soil of the greenhouse was placed at one end of a 3-foot side bed. Next to this, but separated by a tight board partition, was placed 96 square feet of clean soil.

Formalin Treatment of Plots—To these plots was applied one gallon of a 3.25-50 formalin solution to each square foot of surface. Immediately after applying the formalin solution, the soil was covered with several thicknesses of old carpet and old fertilizer sacks, which thus helped to hold the fumes in the soil and thus increase its disinfecting power. This covering was removed two days after the application. To facilitate drying, and aid the fumes in passing from the soil, it was stirred on the third and sixth days after the drenching. The soil lay from 5 to 6 inches deep in the bed, and dripping was very prevalent from the bottom of the bed when 100 gallons of the solution had been applied to the 120 square feet of surface. To see if the bottom layer of the soil was as well saturated as the top, a portion of the soil was inverted, and the lower end was found to be well saturated and giving off characteristic formalin fumes. As muck soils absorb large quantities of any solution, it was approximately half saturated with water before the formalin solution was applied. This is an important factor, and determines how much of the formalin will be retained by the soil before dripping occurs. After the bench is dripping freely at all parts of its bottom, it is a waste of material to apply more of the formalin solution. With muck soil, previously one-half saturated, it undoubtedly would have been better to have used 7.5 pounds of formalin to 100 gallons of water instead of the same amount to 120 gallons.

Sowing of Seed—Three plots of 3 square feet each were laid off on the old soil treated with formaldehyde for the purpose of testing just when celery seed could be sown without sustaining injury from the formalin. The formalin solution was applied February 28. Approximately, the same amount of seed was sown upon each plot, 3, 7 and 11 days subsequent to the application of the formalin. Seed was sown on the remaining 111 square feet 11 days after the application in order to make a comparison of plants grown on both kinds of soil after the treatment.

Effects of Formalin on Seed Germination—Seed sown 3 days after the application germinated approximately one-half as well as those sown 7 days after. Those sown 11 days after the application germinated approximately two-thirds as well as those sown 7 days after.

This part of the experiment shows: (a) that the 3-day period prevents some of the seed from germinating; (b) that the 7-day period is the proper time to sow celery seed in order to get a maximum stand of plants; (c) that formalin has its maximum stimulating effect upon celery seed germination when the seed are sown at the end of the 7-day period.

Effect of Formalin Upon the Subsequent Growth of the Plant—Frequent observations were made upon the plants throughout their seed-bed growing period. The plants in the 3-day plot were much scattered, but showed few weak-looking seedlings which would seem to indicate that the formalin permitted only the seed of strong vitality to germinate.

The 7-day plot had more stocky-looking plants for the first five weeks than either of the other two. After this, due to their crowded condition, the plants became less stocky and grew rapidly. The 11-day plot grew rapidly, but failed to equal those in the 7-day plot.

Formalin Experiments in Hothouse No. 2—After seeing the disinfecting power of formalin upon the soil house No. 1, and at the request of Mr. Spell, a neighbor grower, who lost this spring practically his whole house of first-crop celery seedlings, a more careful and extensive series of experiments were planned in order to verify the experiment in house No. 1.

Briefly outlined the experiment ran as follows:

A portion of the seed-bed containing badly contaminated soil was chosen. This was divided into 8 plots containing exactly 3 square feet each. Seven of these plots were treated with a 3-25-50 formalin solution after the same manner as those in house No. 1. The one plot was untreated and served as a check; 0.77 gm. of seed was carefully weighed out for each plot. Plot 1 was sown forty hours after the application. Plots 2 to 8 were sown at 2-day intervals after Plot 1.

Results from Formalin Treated Plots in House No. 2—This experiment verified all results obtained in house No. 1. In addition it showed (a) that the most viable seed would germinate in a formaldehyde soil 40 hours after the application; that there was a gradual increase in the number of germinated seeds until the maximum was reached in the 7-day plot; that the seedlings in the formalin-treated plots were healthy, whereas in the check three-fourths of them died.

Fertilizers for Hothouse Plants—Celery seedlings are very sensitive to unfavorable environments. If the proper nutrition is not in the soil the plant weakens and is soon attacked by parasitic organisms. The plants in these two houses were carefully watched and as soon as they were noticed to be on the decline an application of nitrate of soda, at the rate of 0.03 of a pound to the square foot of surface was applied over the entire house. In addition dried blood and potash (KCl) were applied to certain plots. These fertilizers soon brought the seedlings back to their proper state of growth.

Spraying the Hothouse—Although neither the early nor late blight appeared on the seedlings, they were sprayed March 31 and April 11 with a 3-4-50 Bordeaux mixture. Due to the waxy secretion of the leaf, the spray had a tendency to collect at the base of each leaflet. This was overcome by the application of 3 to 4 pounds of laundry soap to 50 gallons of the spray.

Bordeaux seemed to act as a stimulant. The line of demarcation between sprayed and unsprayed plots was indicated by an abrupt offset. Measurements were made April 20 on a large number of plants in both sprayed and unsprayed plots. The spray seedlings showed an average increase in height of 0.31 inches over those in the checks.

III. Crown Rot in the Field

Occurrence—This disease has been prevalent in this region for over ten years. It started in a plot of ground that had a very heavy vegetation of fern growth previous to the clearing. From this center of infection it has spread outward until it is now found more or less on nearly every farm in this region.

Organism—The causal organism apparently is a soil bacterium or a bacterium and fusarium working simultaneously. At the present time the writer refrains from a further discussion of the organism until further studies have been completed.

Disease—The organism upon its first entrance into the plant through one or several of the main side roots gives the vascular system in the roots and crown a yellowish-brown appearance. Once in this system, it spreads out laterally, rotting the adjoining tissues. As a result of the above method of progress of the organism two or three of the leaves on one side of the plant are at first observed to be yellowing. This spreads to the entire foliage in from 2 to 4 weeks, causing a gradual dying of the plant.

Varieties Susceptible—The organism mainly affects the Golden Self-Blanching celery, making it impossible to grow the main commercial variety. The new Easy Bleacher celery partially solved the problem for this year, as it is partially resistant to the organism and brought the same price as the Golden Self-Blanching. The green stem varieties are entirely resistant, but are undesirable as a commercial crop for the entire year.

Object—The object of the experiment briefly outlined was as follows:

1. To find the germicidal values of various chemicals toward the crown rot organism.

2. To see if certain compounds would stimulate the plant to such an extent that it becomes resistant to the organism.

3. To discover the effect these chemicals in varying amounts might have upon the growth of the celery plants.

Plot Project—Table III shows the arrangement of the chemically treated plots and the amounts applied. All plots were 30 x 15 feet, except Plots 1 and 2, which were 5 x 15 feet. Two different locations were used in order to have all plots in the worst contaminated soil.

Results—Golden Self-Blanching celery was planted in each plot for the first and second crops. Due to healthy plants from the treated hothouse and exceptionally favorable weather conditions the first crop was partially free from the disease. The second crop was severely attacked and most of it was lost.

Formalin (*CHOH*)—This was applied a few days after the spring plowing. Forty per cent formalin applied at the rate of 3,000 and 4,608 pounds per acre gave a partial control for the second crop. At 8 cents per pound, this would cost from $240 to $368.64 per acre.

That formula applied at the rate of 3,000 pounds per acre is very toxic to celery seedlings is shown by the following results: One dozen seedlings were placed in soil, as above treated, each day after the application, for 13 successive days. All plants died inside of a few hours until the eighth day, when 2 out of a dozen lived for one day. Each succeeding day's planting showed that the toxicity was gradually passing out of the soil by the fact that more plants lived the longer the time was extended. On the tenth day the soil was thoroughly stirred by spading and the plants set on the thirteenth day. Approximately 90 per cent of the thirteenth day planting lived.

Table III

Arrangement of Plots in Experiment on Control of Rot

Plot 1. CaCl 1.3 lbs.	Plot 2. FeSO₄ 2.0 lbs.	Plot 3. Check Untreated.	Plot 4. Ferrous Sulphate 3 lbs.	Plot 5. Formalin 27 lbs.	Plot 5. Check Untreated	Plot 7. Sulphur 10.4 lbs.	Plot Copper Sulphate 0.3 lbs.	Plot 9. Check Untreated.

Plot 10. Check. Untreated.	Plot 11. Calcium Chloride 5.2 lbs.	Plot 12. Ferrous Sulphate. 5.2 lbs.	Plot 13 Check. Untreated.	Plot 14. Formalin. 48 lbs.	Plot 15. Sulphur. 10.4 lbs.	Plot 16. Check. Untreated.	Plot 17. Sodium Chloride 28.8 lbs.
Plot 18. Potassium (KCl). 10.4 lbs.	Plot 19. Check. Untreated.	Plot 20. Horse Manure. 700 lbs.	Plot 21. Copper Sulphate 1.035 lbs.	Plot 22. Check. Untreated.	Plot 23. Calcium Chloride 3.0 lbs.	Plot 24. Ferrous Sulphate 3.0 lbs.	Plot 25. Check. Untreated
Plot 26. Formalin. 32 lbs.	Plot 27. Sulphur 10.4 lbs.	Plot 28. Check. Untreated	Plot 29. Sodium Chloride. 28.8 lbs.	Plot 30. Potassium (KCl). 10.4 lbs.	Plot 31. Check. Untreated.	Plot 32. Copper Sulphate. 0.5 lbs.	Plot 33. Horse Manure. 700 lbs
Plot 34. Check Untreated	Plot 35. Sodium Chloride. 28.8 lbs.	Plot 36. Potassium (KCl). 10.4 lbs.	Plot 37. Check. Untreated.	Plot 38. Horse Manure 700 lbs.	Plot 39. $FeSO_4$, KCl, $CaCl_2$ 10.4 lbs.		
Plot 40. Calcium Chloride. 3.0 lbs.							

Each plot contains the number of pounds applied to it.

The plants of the three formalin-treated plots were free from Early Blight (*Cercospora apii*) until they were infected from adjoining plots. Thus it would seem that formalin served as a soil disinfectant against this organism.

Calcium Chloride ($CaCl_2$)—This salt does not neutralize acidity but is very toxic to most of the soil flora. It was applied March 31 in varying amounts as shown in Table III. Plot II, which received an application at the rate of 500 pounds per acre, gave an increase of 20 per cent in the first crop over the checks.

Copper Sulfate ($CuSO_4 5H_2O$)—This salt, applied at the rate of 30 pounds per acre on Plot 8, gave a 75 per cent control. As this chemical is very toxic to plant growth it is interesting to note that plants were not injured by an application of 100 pounds per acre.

Ferrous Sulfate ($FeSO_4 7H_2O$)—This salt is toxic to plant growth. It gave a slight control in one plot.

Composite Fertilizer, Potash and Horse Manure—These fertilizers increased the growth of the plants very much, but gave no control.

Sodium Chloride ($NaCl$)—As this is not a fertilizer, the purpose of its use was to set free the potash already in the soil. It showed favorably in one plot.

IV. Steam Sterilization

Object—The main objects of the experiment were as follows: (1) to discover if steam or steam plus formaldehyde would sterilize muck soil against the Crown Rot organism; (2) to arrive at some conclusions as to the practicability of using steam for soil sterilization on a field basis; (3) to determine how much pressure and for how long it should be maintained in order to render sterilization complete.

Field Operations—Operations were begun in the field on May 1, 1916, and continued for 6 subsequent days. A few days previous to commencing the soil had been thoroughly worked and made ready for planting.

Outfit

Engine—This part of the apparatus was a 6-horse power portable locomotive, Ajax boiler, which maintained a pressure from 60 to 85 pounds, with the gate valve slightly open.

Hose—The difficulty in moving a boiler over muck soil necessitated 80 feet of 1-inch rubber hose to connect it with the pan. This was very efficient and withstood all pressure to which it could be subject.

Pans—Kinds—Two pans, the one constructed of galvanized iron, and the other of spruce and hemlock, were used.

Galvanized Pans—These were built 10 feet long, 6 feet wide and 8 inches deep, of No. 22 gauge galvanized iron, bound around the bottom by a 2" x ⅛" sharpened band iron, and reinforced over the top and sides with four strips of 1¼" x ⅛" angle iron. Two of these ran crosswise of the pan and the other two lengthwise, attaching at their ends to the band of iron. The joints were folded double-seamed and soldered. The steam inlet was

in the center of the top and had a 1-inch flange junior and nipple bolted to the top. This was connected on the inside to a "T" into which screwed two 14" 1-inch iron pipes which carried the steam toward the two ends. This could be improved by using four 1¾-inch pipes instead of two, and having each one of them extended in the direction of one of the four corners, terminating two-thirds the distance between the inlet and the corners. The above suggested itself by an examination of the soil after raising the pan. Generally, the center soil was from 10° to 15° F. lower than that near the corner. All parts were riveted with malleable iron rivets 4 inches apart. For ease in handling two galvanized malleable iron handles were riveted to each end.

This method of adjoining, soldering, riveting and bracing made a rigid but lightly constructed pan of 250 pounds weight which withstood shipment and field usage in a very satisfactory manner. The cost of this pan complete was $35.00.

Wooden Pans—Due to the high cost of constructive material used in making a galvanized pan, it was thought that some sort of a box might be constructed that would serve in the same capacity. Thus, a box 10 feet long, 6 feet wide and 10 inches deep, was constructed as follows: two sides and two ends from three pieces of hemlock 12' x 8' x 2"; the top from 8 pieces of grooved spruce boards 13' x 8" x 1¼"; two top spruce braces running lengthwise of the pan 12' x 2" x 3"; 32 feet of 2¼" x ¼" continuous sharpened iron band around the bottom of the ends and the sides; 10 pounds of white lead, 3¼ dozen 11-25-inch screws and 5 pounds of nails used in joining. Steam was admitted in the same manner as described for the galvanized pan. It required four men to change it from plot to plot, but when once in the soil little trouble was experienced by the lifting power of the steam. It is to be preferred to the galvanized pan for field work. The box complete cost $17.78.

Temperature—A temperature of 210° to 215° F. was maintained for 1½ hours. This was taken by boring a hole through the top of the wooden pan near one end and inserting a thermometer.

Cost—Due to the inefficiency of the boiler used in this experiment there was approximately $125 for the sterilization of 1/45 of an acre. However, the results showed that steam sterilization will control the disease. If this were taken up by a community, and an efficient boiler purchased so as to keep four 100-square foot pans in continuous operation, it could be made practical, as the following figures will show. Allowing 45-minute periods, four pans would steam sterilize 5,333 square feet of soil per day, or in 8 days approximately 1 acre. Barring the initial cost of the outfit, which would be a small item in community work, the problem resolves itself to a question of labor and fuel. The labor of four men in this community could be had for $10 per day. For the 8 days this would amount to $80. Add to this the liberal allowance of $20 for fuel and the cost of various miscellaneous articles, would total $100, the approximate cost for the sterilization of one acre.

Plots—These plots were 20 feet long and 12 feet wide. All rows ran lengthwise.

Results—First Crop—The first crop consisted of four rows of Golden Self-Blanching celery. They were planted May 20 and harvested August 31.

From averages in the first crop the checks produced as many pounds as the treated plots. The failure to give better results with this crop was probably due to the physical condition of the soil.

The Second and Third Crops—The second crop consisted of one row; the third of two. The second crop was planted June 14; the third July 17. Both were harvested November 9. These crops showed a very decided gain in all plots for the steam sterilization, as may be seen from Table IV.

Table IV

		Weights in Pounds.	
Plots.	*Treatment.*	*First Crop.*	*Second and Third Crops.*
1	Check-untreated,	15.00	20.00
2	Check-untreated,	10.00	18.00
3	Steam,	53.75	50.00
4	Steam + 20 lbs. formalin,	86.25	71.00
5	Check-untreated,	130.00	29.00
6	Steam + 20 lbs. formalin,	79.25	112.00
7	Steam,	95.00	81.00
8	Check-untreated,	90.00	8.50
9	Check-untreated,	96.00	7.00

V. Heart Rot of Celery

The Disease—The disease is caused by a bacterium. In the plant it produces a rotting which gives off a putrid characteristic smell. It attacks only the innermost tender heart petioles and leaves. From 6 to 13 of these have been observed to be infected in one plant. Generally, it starts at the tip of the leaves, and from this point of infection extends downward to the stem. However, cases have been observed where infection has taken place directly upon the stem. That the trouble is a serious one may be seen from an examination of the data taken from four celery plots. These plots grew approximately 92,000 mature plants, of which only 9,720 were free from this disease. The remaining 85,280, or 92 per cent of the crop, represent an entire loss. Reckoning these at 30 cents per dozen, this would incur a pecuniary loss of approximately $2,000.

Organism—The organism has been successfully isolated according to Koch's four rules. It is a bacillus non-acid former, making a rather slight growth upon most media. It is very active upon plants when they are artificially inoculated, causing the characteristic lesions to appear in less than 10 hours.

VI. Crown Rot Wilt

Disease—This disease has been found only upon plants almost matured. It is a matter of chance if a diseased plant is found in its early state, as there are no external symptoms of the disease above ground until it has progressed far into the plant.

Upon examining the roots of diseased plants it was found that the tap root and surrounding roots were invariably rotted or in an advanced state

of decay. These roots led directly to the diseased portion of the crown. To determine that the disease did enter the crown through the roots a number of diseased plants were chosen and the outside portion of the crown carefully cut off to see if there were any lesions leading to the inside cavity. None of these crowns showed any openings in their inside cavity. Thus it is only logical to conclude that the plants are infected only through the roots and rootlets. The organism once in the crown produces an ovoid cyst approximately 30 mm. in length and 15 mm. in diameter at its thickest portion. The medullary rays of the crown tissues are but slightly attacked and fall over on the sides of the cavity as folds. The rot is semi-wet in some cases, while wet in others, and in all instances producing a disagreeable odor. The first noticeable effects upon the foliage are a quick and severe wilting of the entire foliage as if the plants had been severely scalded. Plants that looked perfectly healthy at 6 A. M. are flaccid and prostrate on the ground by noon of the same day. This sudden and rapid wilting can be accounted for only in the following manner: The organism starts its work, as a rule, in the central region of the crown. It gradually works its way outward until it reaches the vascular bundles. Until this time the plants have a perfectly normal outward appearance. The bundles are then rapidly decomposed and the plant wilts as a result of its water supply being cut off. This year the disease caused but little loss. It is much feared by the growers because of the damage it has done in the past.

Organism—The writer has in culture an organism that appears to be the causal one, but refrains from further discussion until more experiments can be conducted.

VII. Early Blight (*Cercospora apii* Fr.)

Disease—Description—As the disease becomes apparent in the field, the infected area of the plant appears light yellow in color, soon becoming an ashen gray surrounded by a small light yellow area. While this change of color has been in progress the spot has become much sunken and the margin well defined. The mycelium now rapidly multiplies in the infected tissues, and occasionally parts of it are projected through the epidermis as fascicles of conidiophores upon which conidia are borne. As the spot reaches maturity it grows larger, turns a light brown color and is generally surrounded by a halo of yellow.

If moist weather conditions prevail, the mature spot becomes covered on both sides with a heavy mass of conidia and conidiophores. Spots frequently coalesce, consuming an entire leaf. The spots are amphigenous upon both stem and leaf. They may be circular, subcircular, triangular, angular, or half-moon in shape, according to their location upon the leaf. The stem may be infected directly by spores or by a continuation of the mycelial growth from the leaflets. The infected area becomes much water-soaked, sunken, and elongated in the direction of the longest axis of the petiole.

Seed-Bed Infection—With this point in view, and from the large number of seed-bed plants the writer has seen, he has never succeeded in finding a single Cercospora spot on any seedling under 6 weeks of age. From labor-

atory work it has been found that spores die after being exposed to desiccation from 2 to 3 months. This, accompanied with the fact that seed is rarely sown by most growers under 2 years, would point to the fact that there is little or no danger of spreading the disease by seed.

First Appearance of the Disease—In this region the disease first made its appearance simultaneously over most of the farms between June 6 and 10.

Weather—Moist, warm, weather affords the most ideal conditions for the rapid development and dissemination of this organism. From June 6 until August 30, the amount of infection gradually became worse. During the latter half of this period high temperature and heavy fogs prevailed with an increasing seriousness of the disease. From August 30 the disease was gradually on the wane until November 1, when scarcely a Cercospora spot could be found over the entire acreage.

Means of Dissemination—Manures, winds, animals, insects, tools, rain and cultivations are the main factors in the spreading of this organism.

Losses—In this region the loss on the unsprayed plots varied from one-third to total for the first and second crops.

Organism—The organism belongs to the "Fungi Imperfecti" and is classified as a Moniliales-dematiaceæ-scolecosporæ.

In the leaf and the petiole of the leaf the mycelium is intercellular, filling the intercellular spaces and the region of the middle lamellæ with sclerotial bodies.

In culture the organism produces an abundant olivaceous floccose growth of mycelium which bears conidia very sparingly.

VIII. Late or Black Blight

(*Septoria petroselini* Desm. var. *apii* Br. & Cav.)

On Leaf—This blight is first brought to our attention by a small area of the leaf turning yellow, followed by a rapid sinking of the entire yellow area and changing of its color to brown. At this period the spot has a definite, regular border, and soon begins to produce scattered pycnidia in no definite location. The pycnidia are small, papillate, pinhead bodies which produce the conidia. They may occur upon either surface of the leaf, but in the Oradell-Ridgewood region they are ten times as numerous upon the upper surface of the leaf as on the lower. The infected area continues spreading until it has reached maturity. In this State it appears with a light-brown central area surrounded by concentrically arranged dark-brown cotigenous region between it and the border. Immediately on the outside of the border is another area of light yellow color.

If the spots are numerous, coalescing often results, in which most of the leaf is finally reduced to a dry, shriveled mass.

On Stem—On the stem the organism produces an elongated, water-soaked area which soon becomes dotted with pycnidia. Infection may come from leaflet infection or from direct spore infection. In the stem the mycelium is intercellular and frequently forms sclerotial-like bodies.

Seed-Bed Plants—From a large number of examined seed-beds none were found that had the late blight.

First Appearance in the Field—The disease first appeared in the Oradell-Ridgewood region July 15, and on the plots at the New Jersey Agricultural Experiment Station farm July 18.

Spreading—This disease is disseminated by the same agents as mentioned under Cercospora.

Losses Caused by Late Blight—The losses caused by the late blight organism upon different farms in this region varied from the entire absence of the disease to a nine-tenth loss.

The Organism—The organism belongs to the "Fungi Imperfecti" and is classified as Sphæropsidales-scolecosporæ. The spores are needle-shaped generally 2-4 septate and occur in small papillate-pycnidial bodies. In culture it produces a very carbonaceous growth in the media while the surface is covered with a grayish-white aerial growth.

IX. Over-wintering of Cercospora apii Fr. and Septoria Petrosilini Desm. var. apii Br. & Cav.

Laboratory studies during the past two years of pure culture of these organisms in different media, and under different environmental influences, such as light, temperature, moisture, etc., without discovering the perfect stage of either, have led the writer to conclude that they are not produced readily or at all in artificial media.

Further evidence has its bearing along this line in that diseased leaves have been kept out-of-doors in wire baskets throughout the year and examinations made from time to time to see if the perfect stage had developed. Likewise, this failed to show the perfect stage. Also laboratory work shows that the Cercospora spores die after 3 months of desiccation. Likewise, it was found that Septoria spores die after 8 months of desiccation.

The above work has led the writer to believe that the organisms must winter as live sclerotial bodies in the leaf and petiole tissues. On September 21 of this year, with this point in view, three lots of fresh celery leaves, badly infected with Cercospora, were placed in the field at three different levels relative to the earth's surface, viz., on the surface, and 7 and 10 inches, respectively, below. The Septoria organism was treated in the same way, except that it was buried at another place on October 15.

A 2¼ x 2¼-inch top and bottom galvanized wire netting of a ⅜-inch mesh was used as a protection to the buried material. Examinations have been and will be made throughout the coming year to determine the longevity of the spores and the sclerotial masses of mycelium. No results can be given at this time (November 20, 1916).

X. The Spell Spray Experiments

No. 1—This project was started July 21 in the worst diseased area of the region. Both the early and late blight were present.

The primary object was to see if a Bordeaux 5-6-50 would control these blights after they had gained a foothold.

The plots consisted of 6 1/40-acre areas of Golden Self-Blanching celery. Three plots each of the second and third crops were sprayed and three were left unsprayed. The dates of the first and last spraying were as follows: Second crop, July 21 and September 20; third crop, August 21 and October 27. The second crop was sprayed on 5 different dates. The third crop on 6 different occasions.

The following is an explanation to Table V, which relates to Spell's experiment:

Bordeaux, 5-6-60, ...Nos. 1, 3 and 5.
Checks, ...Nos. 2, 4 and 6.
F=First crop in lbs. S=Second crop in lbs.

Table V

Results of Spell Spray Experiments

Plot 1		*Plot 2*		*Plot 3*		*Plot 4*		*Plot 5*		*Plot 6*	
F	S	F	S	F	S	F	S	F	S	F	S
795	801	432	456	846	775	387	302	783	678.6	355	360.6

Discussion—The data from Table V show that the second crop which was sprayed to prevent *early blight* averaged 808 pounds for the sprayed plot and 391.3+ pounds for the unsprayed. This increase is 25.4 pounds in excess of a double yield for the sprayed over the unsprayed.

Also the data from Table V show that the third crop which was sprayed to prevent late blight averaged 751.5+ pounds for the sprayed plots and 372.8+ pounds for the unsprayed. This increase is 5.9 pounds in excess of a double yield for the sprayed plots over the unsprayed.

The early blight caused 99 per cent. of the damage in the second crop. The late blight, as previously stated, was present, but due to the warm weather conditions at that time of the year spread but slightly. The sprayed plots, when harvested October 3, showed only scattered spots of the early blight, whereas the checks were badly rotted by the Cercospora organism.

The third crop was harvested November 13. Practically all the damage done to this crop was due to the Septoria organism, as the Cercospora began to vanish by the first of September. The Septoria proved to be much more difficult to control, and required more intense applications of the spray than the Cercospora. That both organisms can be checked in their progress with a Bordeaux 5-6-50 is conclusive from this experiment.

No. 2—This project consisted of two rows of Golden Self-Blanching celery, 240 feet in length, sprayed 3 times with 10-50 Kil-Tone, alternating with two unsprayed check rows. The first spray was applied August 1 and the last August 23. The two Kil-tone-treated rows produced 1,088.5

pounds of celery, whereas the two checks produced 747.0 pounds. This shows a total of 341.5 pounds on the two rows in favor of the Kil-Tone spray over the unsprayed plots.

No. 3—Two rows similarly arranged and of the same length as in No. 2 were twice dusted with sulfur dust on August 1 and 8. The checks and dusted plots showed no differences.

No. 4—This project was begun September 20 on six 1/10-acre areas of third crop Golden Self-Blanching celery. The primary object was to determine if a 4-5-50 Bordeaux mixture would give as good results as a 5-6-50 Bordeaux mixture or a 10-50 Kil-Tone. Three sprays were applied, the first September 20, the last October 17.

Explanations of the Table Relating to Project No. 4:

Bordeaux, 4-5-50, ...Plots 1, 3 and 5.
Checks, ...Plots 2, 4 and 6.
All weights are expressed in pounds.

Table VI

Result of Bordeaux Spray

Plot 1 Third Crop	Plot 2 Third Crop	Plot 3 Third Crop	Plot 4 Third Crop	Plot 5 Third Crop	Plot 6 Third Crop
424	265	363.5	310	337	286

Discussion—The average for each Bordeaux plot was 304.8 pounds; that of the checks 287 pounds. This gave a difference of 87.8 pounds in favor of the Bordeaux-sprayed plots. Although these plots were adjoining No. 1, the blight was less severe in the checks. Another reason for the difference between these plots in No. 1 and this one is that there were 4 rows to each plot in project No. 1, whereas there were only 3 to the plot in this project. However, making allowance for this, the Bordeaux 5-6-50 still gave a larger increase.

XI. Tunis Drenth's Spray Projects

This spray project was begun July 19, twelve 1/96-acre plots being used. The first crop consisted of Golden Self-Blanching celery and the second of the New Easy Bleacher. The only blight present was the Cercospora.

The spray materials used were Bordeaux 5-6-50 and Kil-Tone 10-50. Owing to the excessive rain at the time the experiment was started, 6 different applications were necessary. Due to a misunderstanding, the celery in the plots was removed before weighings could be made. However, the writer saw them a few days before removal and can safely state that the sprayed plots were fully twice as good as the unsprayed.

Bordeaux Stimulation—These plots were set about July 3, and were sprayed on *July 19 and 27, and August 7.* Although among plants of the second crop that were blighted with the Cercospora, neither the checks nor the sprayed plots were infected. Thus on August 7 it was decided to discontinue the spraying upon this third crop. From August 10 until the crop was harvested, *November 10, the plants in the sprayed plots grew better and produced heavier stools, as is shown by Table VI. The writer realizes that Bordeaux stimulation is a disputed question; nevertheless, the fact remains that with the same number of plants to each of the plots, with a uniform muck soil, and no disease present, there was a decided falling off in pounds in each of the four check plots. This, together with similar results obtained upon seedlings in the greenhouse, would point to the natural conclusion that a copper spray does have a stimulating effect upon celery plants.

Table explanations:

Bordeaux 5-6-50, ...Plots 1, 4, 7 and 10.
Kil-Tone 10-50, ...Plots 2, 5, 8 and 11.
Checks, ...Plots 3, 6, 9 and 12.
All weights are expressed in pounds.

Table VII

Results of Spraying with Kil-Tone and Bordeaux

Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12
434.5	419.5	380.	428.5	417.	380.5	448.	447.5	364.5	432.5	423.5	394.

XII. Kniper Spray Projects

This experiment was started July 28. The object of the experiment was two-fold, viz., (a) to discover if a Kil-Tone 10-50 and a Bordeaux 5-6-50 would control the disease, and (b) to see which of these two sprays would prove to be the more efficient. The results are given in Table VIII.

The experiment consisted of eight 1/40-acre plots. Each of the sprays was used on 3 different plots. Three crops of Golden Self-Blanching celery were grown. The loss in the first crop was due mainly to the Cercospora organism, whereas in the second crop the injury was about equally distributed between it and the Septoria organism. The third crop loss was almost entirely due to the Septoria organism.

Table explanations:

Bordeaux 5-6-50, ...Nos. 2, 5 and 8.
Kil-Tone 10-50, ...Nos. 1, 4 and 7.
Checks, ...Nos. 3 and 6.
F=First crop. S=Second crop. T=Third crop.

Table VIII

Results of Kniper Spraying Experiment.

Plot 1			Plot 2			Plot 3			Plot 4		
F	S	T	F	S	T	F	S	T	F	S	T
253	303.5	242	240	270.5	222	183.5	174.5	163	199	231	268.5
Plot 5			Plot 6			Plot 7			Plot 8		
F	S	T	F	S	T	F	S	T	F	S	T
196.5	264	240	140	124	107	208	219	267.5	224.5	247	232

The first crop was sprayed 3 times, the second 4, and the third 6 times. In all cases the Cercospora and Septoria blights were present when the experiment was started.

Discussion—The averages for each plot of the following crop were: Bordeaux 220.5 pounds, Kil-Tone 220 pounds, checks 166.25 pounds. For this crop the two sprays gave an average increase of approximately 33 per cent over the checks.

The average for each plot of the second crop were: Bordeaux 260.5 pounds, Kil-Tone 251.1 pounds, checks 149.25 pounds. This gave an approximate increase of 40 per cent over the checks in favor of the two spray materials. The averages for each plot of the third crop were: Bordeaux 259.6+ pounds, Kil-Tone 231.3+ pounds, checks 135 pounds.

XIII. Drenth Bros. Spray Project

This experiment was started August 1. Twenty-seven 1/40-acre plots were laid out and sprayed twice, except Plots 1, 2, 3 and 4, which were sprayed three times.

The primary object of this experiment for the control of late blight was to test sulfur-dust, Bordeaux 5-6-50, Bordeaux 3-4-50, sulfocide, ammonical copper carbonate, Kil-Tone 10-50 and Kil-Tone 5-50 in a series of 3 plots each, distributed over approximately three-fourths of an acre.

The growers do not distinguish between the Cercospora and Septoria blights, and the writer, not being familiar with conditions in previous years, was misled, although not intentionally. Most of this area was badly infected with early blight and since the spraying was started late, this disease was only partially checked in the second crop.

Results will be given from only 6 of the plots. The difference noted is due to the protection against early blight as the late blight never appeared.

Explanation to Table IX: In field arrangement Plots 5, 6, 7 and 8 lay parallel to Plots 1, 2, 3 and 4. Plot 1—Sulfur Dust, Plot 2—Bordeaux 5-6-50,

Plot 3—Check, unsprayed, Plot 4—Kil-Tone 10-50, Plot 5—*Bordeaux* 3-4-50, Plot 6—Check, Plot 7—Ammonical copper carbonate, Plot 8—Sulfocide.

Table IX

Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8
256 lbs.	254	157	141.5	262	142.5	170	118

Discussion—The land in Plots 1 and 5 was better than in the other plots. Plot 5 had 38 less plants than Plot 1, yet it produced 6 pounds more celery. Plots 2 and 6, which lay parallel, had similar soil and the same number of plants. However, Plot 2 produced 111.5 pounds more than Plot 6. Plots 3, 4, 7 and 8 were infected with crown-rot trouble. Due to the large number of dead plants, nothing definite can be said of the spray treatment for the last mentioned plots.

XIV. The James Neilson Project

This experiment was started July 31. Six different applications of spray were made between the above date and September 26, when the spraying was stopped, as no blights appeared.

Bordeaux 5-6-50 and Kil-Tone 10-50 were used as sprays. The celery is still in the ground as this goes to press, so no weights could be included. The crop was attacked by the flea beetle. The spray served as a repellant to this insect, and as a result a difference can be seen between sprayed and unsprayed plots.

XV. The Project on the New Jersey Agricultural Experiment Station Farm

The object of this experiment was to see if one spray would control the early blight organism. A Bordeaux 5-6-50 spray was applied after the organism had started upon the plants. Several hard rains followed, and as a result scarcely any difference could be seen between sprayed and unsprayed plots.

XVI. Hillman Spray Project

On the farm of Charles Hillman, near Paterson, New Jersey, the Station, in coöperation with Mr. L. F. Merrill, the Bergen County farm demonstrator, conducted an experiment for the control of the late blight on celery under the environmental influences of that locality. About three-fourths of an acre growing the New Easy Bleacher celery, which was already slightly infected with the early and late blights, was sprayed with a 5-6-50 Bordeaux mixture August 28. One-half of the same tract was again sprayed with a spray of a similar strength September 20. After September 20 spraying was discontinued, as the blight made little progress on sprayed or unsprayed plots.

On November 2 the field was last examined. The sprayed plots showed a slight increase in growth over the unsprayed, although not enough to more than pay for the cost of spraying. A slight amount of late blight was present on all plots at this time.

Although the experiment failed to bring large financial returns, nevertheless it brought out some important factors.

1. In 1915 the grower lost from one-half to three-fourths of his crop of Golden Self-Blanching celery through the attack of the Septoria fungus. He sprayed once with Bordeaux after the celery was badly blighted, but got no results.

2. Due to this failure in 1915, the grower planted in 1916 a strain of the New Easy Bleacher, which, in this locality, seems to be fairly resistant to fungus attacks, whereas in the Oradell-Ridgewood region it is frequently affected almost as badly as the Golden Self-Blanching variety.

3. The one spray of 1915 and the time of application as previously referred to shows plainly that a systematized method of spraying is very essential in the control of this organism.

4. Why are these epidemics of late blight so spasmodic? It might be argued that certain varieties and strains of varieties are more resistant than others; that one year the seed is more contaminated than in other years; that the climate is more unfavorable some years than others; and that the soil is more unfavorable for the over-wintering and growth of the organism than others.

From laboratory work and field observations for the past 2½ years the writer is more inclined to believe the truth of the real cause, for these sudden epidemics lies in the last two theories of the preceding paragraph.

5. In 1912 the late blight was first noticed on this farm. It gradually became worse from year to year until the epidemic of 1915. Until this year (1915) the seed-bed had been on ground that had never been planted to celery. In 1915 the seed-bed was chosen where considerable blight had been the year before. This year the seedlings were badly blighted, although the seed used in 1914 and 1915 was from the same source. Therefore, if the organism is disseminated by the seed, the blight should have been as severe in 1914 as in 1915. The fact that there was an epidemic in 1915 would indicate that the soil is a medium in which the organism readily passes the winter. The fact that the blight gradually increased in its severity from 1912 to the epidemic of 1915 further substantiates the theory that the organism may over-winter in the soil.

Spray Gains

In computing gains the spray work done on Spell's project No. 1 will be used as a basis, as it was in the midst of one of the worst infected areas.

The question at once arose, "Does twice the number of pounds mean a doubled financial income?" After consulting the leading growers upon this subject and having their statements that it meant a doubling or more in the way of a financial income, the writer feels at liberty to make his computations upon this basis.

Each of the sprayed 1/40-acre plots No. 1 yielded on the average of 46 dozen plants. This year prices have varied between 30 and 50 cents per dozen plants. Reckoning at 40 cents per dozen, the value of 46 dozen would be $18.40, the gross income from one sprayed plot. One-half of the amount, or $9.20, represents what each of the unsprayed plots produced in gross returns. $18.40—9.20=$9.20 gain on each 1/40-acre plot that was sprayed.

Then $368 would represent the gain on one acre of celery minus the cost of spraying. On an average, the spray was used at the rate of 100 gallons per acre for each of the 5 sprays. Then 1/40-acre plot required 12.5 gallons of spray for the season on one crop.

The lime cost 2 cents per pound. The copper sulfate cost 16 cents per pound. A 5-6-50 Bordeaux mixture was used. Then 12.5 gallons of spray would require 1.25 pounds of lime and 1.5 pounds of copper sulfate. Therefore, 26.5 cents is the total cost of material for spraying one plot the entire season. The cost of material for each acre would amount to $10.00. The "Pomona" barrel sprayer was used. It took 2 men 20 minutes to mix and spray one plot. The labor of two men in applying the 5 sprays to one plot would cost 83⅓ cents. Then, the total cost for spraying one plot would amount to $1.09. By the use of a power sprayer the total cost of spraying could be reduced to two-thirds of the amount herein given. $9.20—1.09= $8.11, the gain on a 1/40-acre plot due to spraying. One acre of sprayed celery would yield, at this rate, $324.00 per acre profit over the unsprayed.

Summary

Complete control of hothouse soil organisms pathogenic for celery was obtained in the following manner: The old soil was removed, the house thoroughly swept, and sprayed with a 5-6-50 Bordeaux mixture, after which clean soil was placed in the benches and treated with formaldehyde 3.25-50. Also, old soil was treated with the above-mentioned formalin solution and gave good results.

From the above treatment the largest percentage of good plants were taken from those plots sown 7 days after the application of the formalin.

Dried blood, sodium nitrate and potash gave good results as fertilizers in the hothouse.

A 3-4-50 Bordeaux caused an increased growth of the seedlings in the hothouse.

Steam sterilization gave approximately a seven-eights control for the crown rot organisms.

Formalin, copper sulfate, calcium chloride, and ferrous sulfate were the only chemicals that showed any *germicidal* effect for crown rot.

Celery seedlings will not grow in soil treated with formaldehyde until 13 days after the application.

The Cercospora and Septoria blights were best controlled by a Bordeaux 5-6-50 mixture and a Kil-Tone 10-50 mixture.

The Cercospora occurs early in the year and reaches its maximum degree of dissemination only during moist, hot weather, whereas the Septoria grows best during cool, moist weather.

XIII

REPORT OF POTATO SPRAYING EXPERIMENTS

H. CLAY LINT

Coöperative potato spraying experiments were conducted by the Department of Plant Pathology during 1916. These were very similar in plan and scope to the ones which have been carried on for the past three years.

New Jersey conditions possess peculiar factors bearing upon this problem, and the results obtained during the past year must be correlated with previous work in order to arrive at the best interpretation. Briefly, the situation may be outlined upon the broad basis of the purpose for which potato spraying is done:

(1) *Control of fungous diseases.* New Jersey potatoes are affected with practically every fungous disease of importance, but those which can be controlled by spraying assume only minor importance. The "early blight" (*Alternaria solani*) and the "late blight" (*Phytophthora infestans*) are the two important diseases encountered in the northern potato sections. These can be effectively controlled by spraying, but in New Jersey the late blight is only rarely in evidence except in the more northern counties. Even there it fails to assume the proportions of an epidemic. The early blight ordinarily appears in late July at a time when the potato vines are starting to die normally, so that its presence probably does not decrease the yields materially. The necessity of spraying for the control of fungous diseases does not impress itself, therefore, very forcefully.

(2) *Control of insect enemies.* Undoubtedly, the two principal insect pests of the potato, the Colorado potato beetle (*Leptinotarsa declimlineata*) and the potato flea beetle (*Epitrix cucumeris*), work considerable injury to foliage. Everyone will concede that it is necessary to apply arsenicals of one description or another to control the former. Actual poisoning of the flea beetle is a more difficult task, and to date it can be stated that homemade Bordeaux mixture, to which lead arsenate has been added, is the most effective means of minimizing the ravages of this pest. A better control of the flea beetle, therefore, constitutes the first logical argument for the application of spray materials to potato foliage in New Jersey.

Control of tip-burn and plant stimulation. Recent work has tended to confirm the opinion of many growers and experimenters that one of the chief benefits of Bordeaux spraying arises because of a decreased injury due to tip-burn. Tip-burn is quite prevalent in this State so that a second reason for spraying is apparent.

While the stimulating effect attributed to copper compounds is imperfectly understood, it has been observed repeatedly in our spraying work that the vines on plots so treated remained green for 5 to 14 days longer than vines not sprayed with copper compounds. Even where the diseases were not a factor this has been observed, and it would appear logical to expect increased yields on this account.

Some of our previous experiments summarized in the Annual Reports of the Experiment Station, for 1913, 1914 and 1915, here show marked effects from Bordeaux spraying. Roughly speaking, the increase averages about

30 bushels per acre. The lack of consistent duplications in different parts of the State and the variations due to seasonal factors have tended to discount the favorable reports. From the economic standpoint the value of the increased yield has not always warranted the added expense. Undoubtedly, this farm management phase of the problem must be considered before broad recommendations in potato spraying can be made.

Five experiments were made on first-crop potatoes and one on the second crop during 1916. These were conducted on the farms of Messrs. J. Harry Kandle, at Elmer; John Black, Mount Holly; Edward Winsor, Farmingdale; and H. Courtney Brown, Jamesburg. The fifth was located at the College Farm on a part of the experimental tract of the department. These several experiments will be taken up separately.

Through the hearty coöperation of several commercial concerns, the scope of these experiments has been considerably broadened.

Through Mr. F. H. Pough, its research manager, the Union Sulphur Company of New York has provided the sulfur-lead arsenate dusts, lead arsenate and the machines necessary for applying the dust mixtures.

The Kil-Tone Chemical Company of Newark, New Jersey, has coöperated through their chief chemist, Mr. C. D. Vreeland. This company was especially generous, supplying a large enough quantity for use on the numerous check plots in two of the experiments.

The Sherwin-Williams Company, manufacturers of "Tuber-Tonic," and the Thompson Chemical Company, manufacturers of the "Pyrox," have coöperated through their managers, Mr. C. P. Jarden and Mr. O. B. Briggs, respectively.

"Iron-Age" traction sprayers were generously supplied by Mr. Frank Bateman, of the Bateman Manufacturing Company, of Grenloch, New Jersey.

The courtesy of the growers with whom we have coöperated merits attention. Added labor and expense have been incurred as well as interferences with other work in order to make application at the convenience of the department representative.

Spraying Experiment in Coöperation with Mr. J. Harry Kandle, Elmer, N. J.

This experiment was conducted on the field used in 1915. The area was divided into 37 plots, each 8 rows wide. Irish Cobbler potatoes were planted, but due to the fact that seed from two different sources were used it was necessary to plant 4 rows of each plot with the one type and the remaining four rows with the other in order that the seed would not be a factor.

One ton of 4-8-5 fertilizer was applied at the time of planting during the week of April 12 to 19. Four applications of spray were made on May 27, June 6, June 17, June 29. The following materials were used:

Kil-Tone—10 lbs. paste to 50 gal. water.
Bordeaux mixture—5-5-50 + 3 lbs. of lead arsenate.
Lead arsenate—3 lbs. dry powder to 50 gal. water.
Pyrox—10 lbs. paste to 50 gal. water.
Tuber-Tonic—3 lbs. dry powder to 50 gal. water.
Lime-sulfur—1 gal. to 49 gal. water + 3 lbs. dry lead arsenate.
Sulfur-lead arsenate—5 parts of sulfur to 1 of lead arsenate.

All wet sprays were applied at the rate of 100 gallons per acre. Thirty pounds per acre of the sulfur-lead arsenate were used. It is to be noted that probably larger quantities of materials were used than were necessary, but it was desired to put all materials on a uniform basis and to obtain maximum results if possible. Having established these, it will then be necessary, of course, to work out the minimum quantity required to obtain this maximum result. In the case of Tuber tonic too large a quantity was

Table X

Yields from Plots in the Spraying Experiment Conducted in Coöperation with J. Harry Kandle, Elmer, N. J., 1916

Plot No.	Treatment	Yields in Bushels Per Acre					
		Kandle Seed			Minch Seed		
		Firsts	Seconds	Total	Firsts	Seconds	Total
1	Kil-Tone, ...	328.49	46.45	374.94	345.08	46.45	391.53
2	Bordeaux, ...	328.99	36.64	365.63	338.95	36.64	375.59
3	Lead Arsenate, ...	317.70	33.19	350.89	282.78	46.57	329.35
4	Kil-Tone, ...	333.10	43.30	376.40	339.76	43.30	383.06
5	Sulfur-Lead, ...	320.20	35.85	356.05	333.54	35.85	384.39
6	Tuber-Tonic, ...	287.22	41.75	328.97	314.42	44.98	359.40
7	Kil-Tone, ...	359.0	38.95	397.95	369.0	42.40	411.40
8	Pyrox, ...	339.0	33.55	372.55	321.0	34.15	355.15
9	Lime-Sulfur, ...	341.5	39.1	380.6	....	....	....
10	Kil-Tone, ...	375.0	35.15	410.15	....	....	....
11	Bordeaux, ...	343.0	44.7	388.7	....	....	....
12	Sulfur-Lead, ...	366.5	36.25	402.75	....	....	....
13	Kil-Tone, ...	355.5	40.6	396.1	....	....	....
14	Lead Arsenate, ...	335.5	42.9	378.4	342.8	48.55	391.35
15	Pyrox, ...	346.7	32.2	378.9	348.0	32.2	380.2
16	Kil-Tone, ...	349.2	34.6	383.8	326.8	34.6	361.4
17	Tuber-Tonic, ...	288.5	42.9	331.4	319.5	39.0	358.5
18	Lime-Sulfur, ...	293.2	39.65	332.85	322.8	47.6	370.4
19	Kil-Tone, ...	347.0	40.8	387.8	314.5	56.6	371.1
20	Bordeaux, ...	343.0	45.0	388.0	349.5	40.9	390.4
21	Tuber Tonic, ...	280.5	47.7	328.2	307.2	43.65	350.85
22	Kil-Tone, ...	350.5	52.75	403.25	346.0	54.9	400.9
23	Lead Arsenate, ...	300.25	47.15	347.45	377.5	43.85	421.35
24	Lime Sulfur, ...	279.0	53.6	332.6	344.7	53.6	398.3
25	Kil-Tone, ...	288.5	53.3	341.8	359.5	53.3	412.8
26	Sulfur-Lead, ...	326.0	49.8	375.8	312.0	58.9	370.9
27	Pyrox, ...	341.2	55.3	396.5	332.0	55.3	387.3
28	Kil-Tone, ...	331.3	47.0	378.3	296.0	51.8	347.8
29	Bordeaux, ...	354.0	38.28	392.28	320.5	47.85	368.35
30	Pyrox, ...	296.8	48.6	345.4	311.2	48.6	359.8
31	Kil-Tone, ...	352.8	54.7	407.5	367.5	47.5	414.7
32	Tuber-Tonic, ...	296.0	36.45	332.45	314.0	32.9	346.9
33	Lead-Arsenate, ...	366.6	32.3	398.9	361.3	34.86	396.16
34	Kil-Tone, ...	345.0	36.9	381.9	....	....	....
35	Sulfur-Lead, ...	334.0	25.5	359.5	....	....	....
36	Lime-Sulfur, ...	324.3	27.47	351.77	....	....	....
37	Kil-Tone, ...	350.5	22.6	373.1	....	....	....

applied for the first two sprays. Some injury to the vines resulted, and for that reason it would be unfair to this material to accept the yields as a correct index of its value when properly used.

The two types of seed used are referred to as "Kandle Seed" and "Minch Seed," respectively. Both Mr. Kandle and Mr. Minch are leaders in the

production of second-crop seed in South Jersey. The Kandle tubers were medium to large in size, had been planted early in 1915, and had arrived at a normal maturity before frost. The Minch seed were quite small, grown from stock planted late in 1915, and had not fully matured before frost. In view of the fact that Mr. Minch advocates the use of these small tubers, this comparison of his seed with the best of what might be called "normal" second-crop seed was considered worthy of attention. In all, there were 28 plots in which these two types of seed were planted. The mathematical average for the Kandle seed was 367.32 bushels per acre and for the Minch seed 378.21 bushels per acre. While this difference is not large, it opens up a very interesting problem in second-crop production.

The yields from the various plots of this experiment are given in Table X. In calculating the influence of any spray material, the "calculated yield" for any particular plot has been computed on the basis of the yields of the check plots on either side. The difference between this calculated yield and the actual yield has been taken as the difference due to the spray material. In this experiment Kil-Tone was used as a check, and the following table shows the relative efficiency of the different spray materials as compared with Kil-Tone:

Spray	*Average Difference*
Kil-Tone,	Check
Bordeaux,	— 4.74
Lead arsenate,	—17.97
Sulfur-lead arsenate,	—18.98
Tuber-tonic,	.....
Pyrox,	—21.31
Lime-sulfur,	—23.44

(Average yield 13 Kil-Tone plots—386 bushels per acre.)

Experiment in Coöperation with Mr. John Black, Mount Holly, N. J.

This experiment was conducted on 27 plots each 8 rows wide. The blocks were located in the middle of an irregular-shaped field, about 35 acres in size. The actual area under test was about 20 acres. The field has been intact for a number of years, and should be very uniform in fertility. The soil is a rather light phase of loam, in a high state of cultivation and admirably adapted to potatoes.

The field was planted with Irish Cobbler potatoes, northern-grown seed. A very uniform stand was obtained and the entire field was listed as one of the best in the vicinity of Mount Holly during the season.

In general, this experiment duplicated the one conducted at Elmer. Bordeaux mixture was used on the check plots rather than the Kil-Tone, as at Elmer, and Tuber-tonic was used as a dry dust in mixture with the Limeoid to demonstrate the advantages of a fungicidal spray over the Paris green treatment most common in this section We set apart three plots to be dusted at the direction of Mr. Black. This might more nearly represent the actual farming practice than if the Department had assumed this direction. In this connection it should be noted that only two applications of Paris green were necessary to control the Colorado potato beetle effectively.

All other plots were sprayed four times during the season—June 1, June 12, *June 19 and June 28, respectively.*

Through the coöperation of Mr. F. E. Embree, of the Burlington County Farmers' Exchange, we were able to test out Mechling's Hydroxcide, a proprietary Bordeaux. This material was used at the rate of 10 pounds to 50 gallons of water.

Table XI

Results of Potato-Spraying Experiment Conducted in Coöperation with John Black, Mount Holly, N. J., 1916

Plot No.	SPRAY	Yields in Bushels Per Acre		
		Actual Yield	*Calculated Yield*	*Spray Difference Due*
1	Bordeaux (Check),	197.74	......	......
2	Hydroxcide,	222.64	212.59	+ 10.05
3	Kil-Tone,	180.90	227.43	— 46.49
4	Bordeaux (Check),	252.29	......	......
5	Lead Arsenate,	229.28	252.31	— 23.03
6	Sulfur-Lead Arsenate,	184.79	252.32	— 67.53
7	Bordeaux (Check),	252.34	......	......
8	Paris Green,	210.29	258.29	— 29.00
9	Tuber Tonic,	246.73	264.24	— 17.51
10	Bordeaux (Check),	270.20	......	......
11	Kil-Tone,	197.21	261.56	— 64.35
12	Lead Arsenate,	280.34	252.94	+ 27.40
13	Bordeaux (Check),	244.34	......	......
14	Sulfur-Lead Arsenate,	242.94	248.07	— 5.13
15	Paris Green,	201.07	251.80	— 50.73
16	Bordeaux (Check),	255.55	......	......
17	Hydroxcide,	236.54	244.15	— 7.61
18	Sulfur-Lead Arsenate,	214.14	232.75	— 18.61
19	Bordeaux (Check),	221.35	......	......
20	Tuber Tonic,	190.25	217.85	— 27.60
21	Kil-Tone,	198.39	214.35	— 15.96
22	Bordeaux (Check),	210.85	......	......
23	Lead Arsenate,	182.81	211.19	— 26.38
24	Tuber Tonic,	173.17	211.53	— 38.36
25	Bordeaux (Check),	211.87	......	......
26	Sulfur-Lead Arsenate,	191.04	211.87	— 20.83
27	Paris Green,	160.67	211.87	— 61.20

The crop was dug about August 14 to 21. The tubers were of excellent quality and the grading was rather close. Consideration should, therefore, be made of this in regarding the yields of first size tubers.

The relative efficiencies of the various spray materials are shown to better advantage in the following table:

Spray Material	*Average difference in bushels per acre*		
	Firsts	*Seconds*	*Total*
Bordeaux (Check)[1]			
Hydroxcide,	+ 1.26	— .04	+ 1.22
Kil-Tone,	— 36.60	— 5.66	— 42.26
Lead arsenate,	— 11.44	+ 4.11	— 7.33
Sulfur-lead arsenate,	— 32.44	— 4.92	— 37.36
Tuber-Tonic.[2]			
Paris green,	— 47.88	— 5.76	— 53.64

[1] Average yield of Bordeaux check plot 225.17 bushels per acre.

[2] Omitted since material was not applied as a wet spray.

Spraying Experiment Conducted in Coöperation with Mr. Edward Winsor, Farmingdale, N. J.

Spraying work in Monmouth County has heretofore been done on potatoes of the American Giant variety. No differences of practical importance were obtained due to spraying treatments in the experiments conducted at Freehold in coöperation with Mr. Frank Jones. It was noted that the exceptional fertility of this field might have been a factor in producing these negative results.

Table XII

Results of Spraying Experiment Conducted in Coöperation with Edward Winsor, Farmingdale, N. J., 1916

Plot No.	VARIETY	SPRAY	Yields in Bushels Per Acre		
			Calculated Yield	Actual Yield	Difference
1	Cobbler, ...	*Kil-Tone,*	......	259.1	......
2	"	Bordeaux-Lead Arsenate,	241.67	251.33	+ 9.66
3	"	Lead Arsenate, ...	224.25	250.33	+ 26.08
4	"	Kil-Tone, ...	......	206.83	......
5	"	Sulfur-Lead Arsenate, ...	215.40	252.0	+ 36.51
6	"	*Bordeaux-Lead Arsenate,*	*224.15*	*301.0*	+ 76.85
7	"	Kil-Tone, ...	......	232.83	......
8	"	Lead Arsenate, ...	226.30	267.16	+ 40.86
9	"	Sulfur-Lead Arsenate, ...	219.73	207.75	— 11.98
10	"	Kil-Tone, ...	......	213.16	......
11	Aroostook Prize,	Kil-Tone, ...	......	301.55	......
12	" "	Bordeaux-Lead Arsenate,	316.92	381.66	+ 64.74
13	" "	Lead Arsenate, ...	331.29	397.66	+ 66.37
14	" "	Kil-Tone, ...	......	347.66	......
15	" "	Sulfur-Lead Arsenate, ...	351.33	338.33	— 13.0
16	" "	Bordeaux-Lead Arsenate,	354.99	345.00	— 9.99
17	" "	Kil-Tone, ...	......	358.66	......
18	" "	Lead Arsenate, ...	362.10	382.00	+ 19.90
19	" "	Sulfur-Lead Arsenate, ...	365.54	370.00	+ 4.46
20	" "	Kil-Tone, ...	......	368.33	......
21	" "	Bordeaux-Lead Arsenate,	368.22	376.66	+ 8.44
22	" "	Lead Arsenate, ...	368.11	353.66	— 14.45
23	" "	Kil-Tone, ...	......	368.00	......
24	" "	Sulfur-Lead Arsenate, ...	357.33	359.16	+ 1.83
25	" "	Kil-Tone, ...	......	346.66	......

Spraying work in other parts of the State in which the results were more favorable was done on Irish Cobbler potatoes. Accordingly, it was planned to test out the various spray materials on the two varieties of potatoes in the same field. Such conditions were generously provided by Mr. Edward Winsor on his farm near Farmingdale.

The soil of this field was a sandy loam in a high state of cultivation, well adapted to potatoes. It is underlaid at a shallow depth by a greensand marl.

While it was impossible to plant the typical American Giant potatoes, the object of the experiment was not destroyed since the Aroostook Prize potatoes actually planted are very similar to the Giants in fact, most buyers fail to differentiate between the two varieties.

The experiment was carried out on 10 plots, each 4 rows wide, with the Irish Cobbler potatoes, and on 15 plots, each 8 rows wide, with the Aroostock Prize potatoes. The different treatments were duplicated on the Irish Cobblers and repeated 3 times on the Aroostook Prize.

Like all other experiments conducted this year, the Irish Cobblers received 4 applications of spray and, as was the case in 1915, it was impossible to spray the Aroostook Prize more than 3 times. The applications of spray were made on May 25, June 5, June 15, June 26. The first spray was omitted on the Aroostook Prize since these potatoes were not sufficiently large for spraying.

The relative efficiencies of the various spray materials are shown to better advantage in Table XII.

Spray Material	*Average Difference from Checks in bushels per acre* *Irish Cobbler*	*Aroostook Prize*
Kil-Tone (Check)		
Bordeaux,	+43.25	+20.73
Lead arsenate,	+33.47	+23.94
Sulfur-lead,	+12.27	— 2.24

Average yield 4 Kil-Tone checks, Irish Cobblers—227.97 bushels per acre.
Average yield 6 Kil-Tone plots, Aroostook Prize—348.47 bushels per acre.

Report of the Spraying Experiment Conducted in Coöperation with Mr. H. Courtney Brown, Jamesburg, N. J.

The experiment of 1916 carried on in coöperation with Mr. Brown is almost a duplicate of the one conducted on this farm in 1915. The field of about 4 acres was divided into 22 plots of 4 rows each, the scheme of treatments being repeated 4 times.

In addition to the usual comparisons of sulfur-lead arsenate, Bordeaux and lead arsenate, it was thought advisable to use the sulfur-lead arsenate as a wet spray as well as a dust. Quite probably a better distribution of the materials is accomplished by the wet than by the dust sprayers. To learn to what extent the yields would differ, due to a more effective method of applying the spray material, this feature was included in this experiment.

The plots of this experiment were sprayed 4 times during the season and the main points of variance between this and other spraying experiments lay in the fact that the sulfur-lead arsenate was applied also as a wet spray, that a more concentrated spray material was used, and that Green Mountain potatoes were grown instead of Irish Cobblers.

The strengthening of the spray solution was necessary because the machine used was able to deliver only 75 gallons per acre instead of 100. It was desired to use the actual amount of materials applied per acre as the standard rather than gallons of spray, and hence the increase.

In preparing the wet mixture of sulfur and lead arsenate it should be noted that a very satisfactory method of wetting down the sulfur is to use a dilute solution of glue rather than plain water in preparing the paste.

The results of this experiment are shown in Table XIII.

Table XIII

Results of Spraying Experiment Conducted in Coöperation with A. Courtney Brown, Jamesburg, N. J., 1916

Plot No.	TREATMENT	Baskets Per Plot	Bu. Per Acre	Calculated Bu. Per Acre	Difference Due to Spray
1	Sulfur-Lead Arsenate (Dust),	41.5	230.8	.....	.....
2	Bordeaux-Lead Arsenate, ...	38.5	204.8	212.4	— 7.6
3	Lead Arsenate, ...	39.5	210.2	194.0	+ 6.2
4	Sulfur-Lead Arsenate (Dust),	33.0	175.6	.....	.....
5	Sulfur-Lead Arsenate (Wet),..	33.5	178.3	195.1	— 16.8
6	Bordeaux, ...	39.3	198.5	214.6	— 16.1
7	Sulfur-Lead Arsenate (Dust),	44.0	234.2	.....	.....
8	Lead Arsenate, ...	42.3	224.8	231.5	— 6.7
9	Sulfur-Lead Arsenate (Wet),..	42.0	223.5	228.8	— 5.3
10	Sulfur-Lead Arsenate (Dust),	42.5	226.1	.....	.....
11	Bordeaux, ...	47.0	250.0	213.8	+ 36.2
12	Lead Arsenate, ...	40.5	215.3	201.3	+ 14.0
13	Sulfur-Lead Arsenate (Dust),	35.5	188.8	.....	.....
14	Sulfur-Lead Arsenate (Wet),..	36.5	194.2	195.9	+ 1.7
15	Bordeaux, ...	43.5	231.3	203.0	+ 28.3
16	Sulfur-Lead Arsenate (Dust),	39.5	210.2	.....	.....
17	Lead Arsenate, ...	36.0	191.5	210.1	— 18.6
18	Sulfur-Lead Arsenate (Wet),..	38.7	206.0	209.9	— 3.9
19	Sulfur-Lead Arsenate (Dust),	41.3	209.7	.....	.....
20	Bordeaux, ...	34.0	180.9	217.9	— 37.0
21	Lead Arsenate, ...	37.5	199.7	226.1	— 26.4
22	Sulfur-Lead Arsenate (Dust),	44.0	234.2	.....	.....

The relative efficiency of these sprays is shown to better advantage in the following table:

Spray Material	*Mathematical Average, Bushels Per Acre*	*Average Difference From Calculated Yields*
Sulfur-lead (dust), ...	213.7	+ .76
Bordeaux, ...	213.1	+ .76
Lead arsenate, ...	210.3	6.30
Sulfur-lead (wet), ...	200.5	—6.32

From the foregoing table it is quite apparent that no difference of practical importance were to be observed in the yields. It is interesting to note that on the basis of the mathematical averages of the yield on the various plots there is a difference of —13.2 bushels per acre. On the basis of the difference between the actual and calculated yields, the average is only —6.32 bushels per acre. Similarly, the average difference between sulfur-lead dust and lead arsenate is changed from —3.4 to —6.3 bushels per acre. In this case the difference is an increase, in the former a decrease. In no event are the differences especially indicative either way, but they illustrate the importance of method in interpreting the same plot yields.

The fact that the sulfur-lead arsenate was less effective when applied wet than dry is quite the reverse of what was anticipated when the work was started. It was thought that the more even distribution of the material would give an increased rather than a decreased yield. Exactly the same quantity, 30 pounds per acre, was applied by the two methods.

Report of the Potato Spraying Experiment Conducted on the Plant Pathology Plots, New Brunswick, N. J.

This experiment was designed to permit a more intimate study of the influence of Bordeaux mixture spraying on potatoes than is possible in the coöperative experiments throughout the State conducted on a commercial scale.

Instead of the plot, the hills themselves, being harvested separately, served as the basis of comparison. Variations in our previous results were possibly due, in part, to the fact that different varieties of plants may not respond in like manner to Bordeaux treatment. To see to what extent such a factor is operative we used 4 varieties of potatoes.

Three of the varieties used are undoubtedly of greatest importance within the State. They are the Irish Cobbler, Giant and Green Mountain. A fourth variety, the Jersey Red Skin, was used since interest has again been taken in this variety in certain parts of South Jersey.

Four rows of each variety of potatoes were planted, and in order to eliminate the seed as a source of variation, the seed tubers were quartered, the four pieces thus formed occupying the same position in the four different rows. The rows in this experiment were 76 feet long, each containing 38 hills placed two feet apart. The rows were 4 feet apart, allowing each hill ample room for its maximum development.

The rows of this experiment with their treatments were as follows:

Row No.	*Variety of Seed*	*Spraying Treatment*
1	Irish Cobbler,	Lead Arsenate.
2	" "	Bordeaux-Lead Arsenate.
3	Jersey Red Skin,	Lead Arsenate.
4	" " "	Bordeaux-Lead Arsenate.
5	Green Mountain,	Lead Arsenate.
6	" "	Bordeaux-Lead Arsenate.
7	American Giant,	Lead Arsenate.
8	" "	Bordeaux-Lead Arsenate.
9	Irish Cobbler,	Lead Arsenate.
10	" "	Bordeaux-Lead Arsenate.
11	Jersey Red Skins,	Lead Arsenate.
12	" " "	Bordeaux-Lead Arsenate.
13	Green Mountain,	Lead Arsenate.
14	" "	Bordeaux-Lead Arsenate.
15	American Giant,	Lead Arsenate.
16	" "	Bordeaux-Lead Arsenate.

The Irish Cobbler seed used was second-crop selected stock grown by Mr. J. Harry Kandle at Elmer, N. J. The Jersey Red Skins were grown by the Minch Bros. of Bridgeton, N. J. The Green Mountain seed was commercial seed secured from New York State. The seed used was selected for uniformity and freedom from disease from a large pile in the warehouse of Chamberlain & Barclay at Jamesburg, N. J. From Mr. D. Howard Jones at Freehold, the writer secured some of the American Giant seed grown especially for Mr. Jones in the mountainous parts of Pennsylvania.

This seed was probably of much better grade than that used in common practice, but the unfavorable soil conditions at New Brunswick did not permit of a large yield.

Table XIV

Influence of Bordeaux Spraying on First-Size Potatoes

VARIETY	Bordeaux-Sprayed			Lead Arsenate-Sprayed				
	Row No.	No. Per Hill	Average Weight of Tubers, gm.	Row No.	No. Per Hill	Average Weight of Tubers, gm.	Difference in No. Per Hill	Difference in Weight of Tubers.
Irish Cobbler, ...	2	1.380	132.3	1	1.000	118.9	+ 0.380	+ 13.4
Red Skin, ...	4	4.630	115.2	3	3.890	133.8	+ 0.740	— 18.6
Green Mountain...	6	3.392	144.3	5	3.580	143.3	— 0.188	+ 1.0
Giant, ...	8	3.110	146.2	7	2.818	150.5	+ 0.292	— 4.8
Irish Cobbler, ...	10	3.110	132.0	9	3.405	145.6	— 0.295	— 13.6
Red Skin, ...	12	4.680	114.0	11	5.000	117.0	— 0.320	— 3.0
Green Mountain...	14	3.945	162.3	13	3.680	180.5	+ 0.265	— 18.2
Giant, ...	16	2.392	143.0	15	2.550	177.7	— 0.158	— 34.7

The potatoes were planted on May 21 and were harvested on October 8. The plants were given 4 thorough applications of spray during the season. It would have been possible to have given more than this number of applications, but since four is the largest number of applications it is possible to make in commercial work, it was thought unadvisable to do so.

Table XV

Influence of Bordeaux Spraying on Second-Size Potatoes

VARIETY	Bordeaux-Sprayed			Lead Arsenate-Sprayed				
	Row No.	Number in Hill	Average Weight of Tubers, gm.	Row No.	Number in Hill	Average Weight of Tubers, gm.	Difference in Number Per Hill	Difference in Weight of Tubers
Irish Cobbler, ...	2	8.90	28.00	1	9.50	24.75	— 0.60	+ 3.25
Red Skin, ...	4	8.66	31.82	3	10.31	29.80	— 1.65	+ 2.02
Green Mountain,..	6	5.05	36.22	5	5.50	39.55	— 0.45	— 3.33
Giant, ...	8	5.57	27.05	7	8.21	29.68	— 2.64	— 2.63
Irish Cobbler, ...	10	5.27	37,10	9	4.57	40.40	+ 0.70	— 3.30
Red Skin, ...	12	10.20	34.30	11	12.40	31.10	— 2.20	+ 3.20
Green Mountain,..	14	7.70	35.70	13	7.87	28.10	— 0.17	+ 7.60
Giant, ...	16	7.66	35.32	15	8.28	31.32	— 0.62	+ 4.00

In harvesting, the yield of each hill was taken separately, and the tubers sorted into two grades. The total number of potatoes to each hill was taken

together with the number of first and seconds. Weighings were made on a torsion balance and weights are within 5 gm.

The results are given in Tables XIV, XV and XVI.

An inspection of the data obtained from this experiment fails to show any consistent advantage in Bordeaux spraying. While the work was done on only a relatively small number of hills, still the conditions were fairly uniform and the data on yields taken with the greatest possible accuracy.

The only indication that shows any consistency in the entire experiment is to the effect that the number of second-size tubers per hill has been decreased by Bordeaux spraying. In 7 out of a possible 8 cases, this fact is borne out. In 5 out of a possible 8 cases these second-size tubers were larger than in the corresponding lead-arsenate-sprayed hills.

Table XVI

Comparison of Total Yields

Bordeaux-Sprayed			Lead Arsenate-Sprayed			Differences Yield (1) gm.	Differences Yield (2) gm.
Row No.	Yield (1) gm.	Yield (2) gm.	Row No.	Yield (1) gm.	Yield (2) gm.		
2	6,885	9,435	1	4,400	8,695	+ 2,485	+ 740
4	20,290	10,485	3	19,800	11,655	+ 1,490	— 1,170
6	18,605	6,953	5	19,500	8,285	— 895	— 1,232
8	16,883	5,730	7	16,210	9,290	+ 673	— 3,560
10	13,880	7,230	9	18,330	6,825	— 4,450	+ 405
12	20,265	13,290	11	22,215	14,635	— 1,950	— 1,345
14	23,700	9,060	13	25,295	8,391	— 1,595	+ 669
16	13,015	10,280	15	17,405	10,095	— 4,390	+ 185

There are apparently no consistent differences in the results due to the variety of potatoes. As far as total yields are concerned, the lead arsenate rows show in 5 out of 8 cases a greater return than the corresponding Bordeaux rows.

In principle, this experiment appears to be in accordance with our best conception at the present time. Soil differences apparently played an important role in these results since the duplicate plots with the same variety of potatoes almost invariably show a reversed effect.

Report of Second-Crop Spraying Experiment Conducted in Coöperation with Mr. J. Harry Kandle, Elmer, N. J.

Very beneficial results were obtained in the second-crop spraying work in 1915. A repetition of this part of the work was, therefore, considered advisable. A field of about 8 acres was divided into 23 plots of equal sizes, each 8 rows wide.

Irish Cobbler potatoes were grown, second-crop seed kept in cold storage until late July being used for planting. Due to the fact that an improved

strain of seed was used on Plot 1, and also that no yield data were taken on Plot 16, it has been necessary to give only the mathematical averages of the yields on the various plots.

The yields on the various plots, together with the yields on the same, are shown in Table XVII.

Table XVII

Plot No.	SPRAY TREATMENT	Baskets Per Plot	Baskets Per Acre	Bushels Per Acre
1	Bordeaux-Lead Arsenate,*	114.0	299.2	187.2
2	Sulfur-Lead Arsenate,	96.0	252.	157.6
3	Lead Arsenate,	94.0	246.8	154.3
4	Bordeaux-Lead Arsenate,	93.0	244.0	152.5
5	No Spray,	90.0	230.5	147.8
6	Modified Kil-Tone,	111.0	291.5	182.3
7	Bordeaux-Lead Arsenate,	111.0	291.5	182.3
8	Kil-Tone,	117.5	308.5	192.9
9	Sulfur-Lead Arsenate,	105.5	277.1	173.3
10	Bordeaux-Lead Arsenate,	107.	281.0	175.7
11	Lead Arsenate,	93.5	245.3	153.5
12	No Spray,	98.5	258.6	161.7
13	Bordeaux-Lead Arsenate,	106.5	279.5	174.8
14	Modified Kil-Tone,	114.5	300.5	188.0
15	Kil-Tone,	103.0	270.6	169.2
16	Bordeaux-Lead Arsenate,	.....	.....	.....
17	Sulfur-Lead Arsenate,	88.0	231.0	144.4
18	Lead Arsenate,	88.5	232.3	145.3
19	Bordeaux-Lead Arsenate,	93.0	244.0	152.6
20	Modified Kil-Tone,	89.0	233.5	146.0
21	Kil-Tone,	89.0	233.5	146.0
22	Bordeaux-Lead Arsenate,	87.0	228.3	142.9
23	Kil-Tone,	92.0	241.5	151.0

* Not included because of difference in seed used.

The comparative efficiencies of the various sprays are shown to better advantage in the following table:

Spray Material	*No. of Plots*	*Average Yield.*	*Difference*
Bordeaux (check),	6	163.46	.....
Lead arsenate,	3	151.03	—12.13
No spray,	2	154.75	— 8.71
Modified Kil-Tone,	3	172.10	+ 8.64
Kil-Tone,	4	164.77	+ 1.31
Sulfur-lead arsenate,	3	158.43	— 5.03

In 1915 the average increase for the Bordeaux plots was about 45 bushels per acre over the lead arsenate checks. This year the increase was only about one-fourth as large. In 1915, both the Colorado potato beetle and the early blight were very prevalent, and it was suggested at the time that the seemingly large increase was probably due to a control of these two pests. This year neither of these was a factor and the decreased effect of spraying would tend to confirm the previous statement. That these factors played a minor role in 1916 is further evident by the fact that the Bordeaux plots yielded only 8.71 bushels per acre more than those not sprayed.

Taken as a whole, the yields are all so close together that by the time the experimental error of the average is taken into consideration, there is no large increase in any case.

General Summary

While other phases of the potato-raising problem are probaoly of greater importance in a practical way, still large amounts of money are spent annually for spray materials of divers descriptions, and from the economic standpoint it is highly important that the most efficient spraying treatment be outlined.

New Jersey conditions are such that many of the principles of potato-raising, which in other States are almost axiomatic, fail to work out. Even within the confines of this relatively small State, the conditions are so variable that results obtained in one section fail of duplication in another.

Generally speaking, the spraying results at Elmer on Irish Cobblers have been quite in favor of Bordeaux mixture. The results in 1916, with an increase of about 20 bushels per acre for Bordeaux over lead arsenate, can be considered as about an average result to be expected there.

At Mount Holly the results this year, in a measure, duplicate those obtained last year. An average increase of 53.64 bushels per acre has resulted from the application of Bordeaux mixture rather than Paris green, the insecticide commonly employed. Lead arsenate shows up uncommonly well, however, with only 7.33 bushels per acre less than Bordeaux, the equivalent of 46.31 bushels per acre over Paris green. Under the conditions of this particular experiment, lead arsenate alone would have been the cheapest material one could have bought. From both the results this year and in 1915 it is quite apparent that lead arsenate as a wet spray is much more economical than Paris green as a dust.

In Monmouth County appreciable differences in yields were obtained in both Irish Cobblers and Aroostook Prize. The fact that these differences were smaller with the Prize than with the Cobblers would tend to confirm our previous opinion to the effect tbat the variety of the potatoes is an important contributing factor.

At Jamesburg the work on Green Mountains practically duplicates the results of 1915. No difference of economic importance has been obtained there either year. Perhaps here again variety, as well as locality, influences results.

Despite the seemingly correct method of experimentation on the plots at the College Farm, there resulted one of the most noteworthy contradictions in results of all obtained in the State. Quite probably the method of experimentation employed on the College Farm, with seed differences compensated for and yields accurately determined for each hill, gives just as indicative results as the large yield experiment.

In general, the commercial sprays have shown up well in comparison with the standard home-made Bordeaux. Mechling's Hydroxcide at Mount

Holly equalled the Bordeaux. Kil-Tone gave a slightly larger yield than Bordeaux at Elmer. It is somewhat singular that at Farmingdale and Mount Holly this material undoubtedly gave lower yields than Bordeaux, and yet at Elmer, in case of both the first and second crop potatoes, the yields were slightly larger than with Bordeaux. Pyrox in the one experiment gave a slightly lower yield than Bordeaux, but when it is considered that the difference is not more than twice the experimental error, there is nothing detrimental to be said of the spray.

Due to the fact that Tuber-Tonic was used in larger amounts than is recommended, it would be unfair to accept the results as indicative of the true merit of this material.

The sulfur-lead arsenate mixture is not as effective as Bordeaux. This could not be expected from any dust mixture. Undoubtedly, better results are obtained from this mixture than from straight Paris green, and when it is considered that in a certain period of time one can dust from three to four times the acreage that can be covered in spraying, it appears that under certain conditions of labor shortage it would be more economical to dust than to spray.

A very thorough application of dust can be made with certain machines now on the market and the problem of dust or spray applications rests on a very careful analysis of the economic factors.

Roughly speaking, the dusting costs about half as much as spraying with home-made Bordeaux. Sulfur dusting costs approximately twice as much as Paris green, but the results thus far point to the superiority of the surfur-lead arsenate mixture.

The past season has not been especially favorable for obtaining large differences. Both insect and fungous pests were at a minimum and the seasonal conditions being especially conducive to growth, would make any increasing of the yield all the more difficult.

The variability of results at different points of the State is again demonstrated. Unquestionably, a better spraying system than the use of Paris green can be devised in some section of the State, particularly on Irish Cobblers. Lead arsenate alone has so closely approximated Bordeaux in several experiments this year that it was undoubtedly the cheapest spray under those especial conditions. For convenience, the commercial preparations have many points in their favor.

The complete answer to the potato-spraying problem cannot be said to have been achieved. Seasonal differences and climatic differences in various parts of the State play such an important role that the evidence of several years more will be necessary before the most economical spraying treatments are determined.

XIV

REPORT OF THE SULFUR-POTATO SCAB EXPERIMENTS 1916

H. Clay Lint

Experiments on the use of sulfur for the control of potato scab (*Actinomyces chromogenus* Gaspini) which were started in 1914 have been continued during the past season. The work has been practically a duplication and continuation of the work of the two previous years.

Six coöperative experiments were carried out in various parts of the State on the farms of the following men: Mr. Walter Minch, Bridgeton; Mr. M. F. Riley, Elmer; Mr. H. W. Ridgeway, Bridgeton; Mr. W. J. MacFarland, Burlington; Mr. J. Carroll Burtis, Allentown; Mr. Earl Dilatush, Robbinsville.

The first four of these experiments were simply repetitions of the 1915 experiments on the same plots. It was also planned simply to repeat the previous experiments on the farms of Mr. Burtis and Mr. Dilatush, respectively, but conditions this spring forbade such procedure and the experiments this year were necessarily carried out on different soil.

In general, the experiment of the past summer provides very satisfactory confirmation of the tentative conclusions submitted on the previous work. Three different sets of climatic conditions have been encountered in the work. The summer of 1914 was essentially dry, 1915 was more moist than usual, while the past season might well be regarded as normal. That the results from sulfur applications for scab control should have shown this degree of consistency permits of a broader generalization than would otherwise have been the case.

The experiments may better be considered separately. Irish Cobbler potatoes were grown on all experiments since this variety is particularly susceptible and is economically the most important.

Report of Experiment in Coöperation with Mr. W. J. MacFarland, Burlington, N. J.

The experiment in coöperation with Mr. MacFarland near Burlington has been carried out according to the plan outlined in the Annual Report of the Experiment Station for 1915. The individual plots were each 100 feet long by 4 rows wide, arranged in 8 parallel strips each 4 plots long. As in all of our experiments the plan has been to have check plots adjacent to each treated plot. The calculated yields and percentage of clean tubers have been completed for the treated plots on the basis of these checks, and the actual benefit is taken as the difference between this theoretical figure and that actually obtained.

The yields were calculated in the same manner as previously reported. In this particular experiment practically the entire yield of the first size tubers was sorted.

The results of the experiments at Burlington are shown in Table XVIII.

Table XVIII

Results of Potato Scab Experiment Conducted in Coöperation with Mr. W. J. MacFarland, Burlington, N. J., Summer of 1916

Plot No.	Seed Treatment	Sulfur, Pounds Per Acre		Actual Percentage of Clean Tubers	Calculated Percentage of Clean Tubers	Effect of Sulfur on Percentage of Scab	Actual Yield, Bushels Per Acre	Calculated Yield, Bushels Per Acre	Effect of Sulfur on Yield, Bushels Per Acre
		1915	1916						
1,	Formalin,	Check	Check	37.65	....	....	123.25	....	....
2,	Formalin,	Check	Check	40.15	....	....	129.08	....	....
3,	Formalin,	Check	Check	46.30	....	....	108.24	....	....
4,	Formalin,	Check	Check	43.80	....	....	133.51	....	....
5,	Formalin,	600	600	56.55	44.45	+12.10	97.00	114.08	−17.08
6,	Formalin,	300	300	53.23	45.79	+ 7.44	92.41	115.68	−23.27
7,	Formalin,	600	600	54.45	52.33	+ 2.12	60.37	106.16	−45.79
8,	Formalin,	300	300	65.20	49.05	+10.15	132.61	138.73	+ .12
9,	Formalin,	600	Check	47.92	53.25	− 5.33	67.26	104.91	−37.35
10,	Formalin,	300	Check	56.50	51.43	+ 5.07	81.02	102.27	−21.25
11,	Formalin,	600	Check	55.00	58.36	− 3.36	82.78	104.04	−21.27
12,	Formalin,	300	Check	66.75	54.30	+12.45	148.53	133.95	+14.58
13,	Formalin,	Check	Check	58.06	....	....	95.74	....	....
14,	Formalin,	Check	Check	57.08	....	....	86.80	....	....
15,	Formalin,	Check	Check	64.40	....	....	101.96	....	....
16,	Formalin,	Check	Check	59.56	....	....	134.10	....	....
17,	Not Treated.	Check	Check	61.35	....	....	96.30	....	....
18,	Not Treated.	Check	Check	60.63	....	....	99.06	....	....
19,	Not Treated,	Check	Check	55.85	....	....	74.48	....	....
20,	Not Treated,	Check	Check	59.30	....	....	79.36	....	....
21,	Not Treated,	600	600	61.40	56.84	+ 4.56	111.96	92.86	+19.10
22,	Not Treated,	300	300	65.20	55.79	+ 9.41	112.25	96.37	+15.88
23,	Not Treated,	600	600	73.15	49.78	+23.37	98.04	79.90	+18.14
24,	Not Treated,	300	300	72.82	53.83	+18.99	101.45	81.26	+20.19
25,	Not Treated,	600	Check	49.75	52.33	− 2.58	86.64	89.36	− 2.72
26,	Not Treated,	300	Check	51.85	50.97	+ 0.88	87.24	93.68	− 6.44
27,	Not Treated,	600	Check	49.75	52.81	− 3.06	76.81	85.32	− 8.51
28,	Not Treated,	300	Check	60.88	56.56	+ 4.32	71.69	83.16	−11.47
30,	Not Treated,	Check	Check	46.15	....	....	85.86	....	....
31,	Not Treated,	Check	Check	46.75	....	....	90.99	....	....
32,	Not Treated,	Check	Check	51.10	....	....	60.75	....	....
....	....	....	....	....	....	....	85.07	....	....

The more apparent features in these results are: (1) The annual application of 300 pounds of sulfur per acre gives as effective control of scab as one of 600 pounds per acre. (2) Where applications of 300 pounds were made in 1915 the scab control the following year has been even better than where heavier applications were made. (3) It is somewhat peculiar, in view of the results on other plots, to note an increased yield on the plots planted with untreated seed to which sulfur was applied in both 1915 and 1916. The mere fact, however, that 10 out of 16 plots variously treated with sulfur during the two years should show a decreased yield conforms with the results generally noted. (4) Little difference in the amount of scab is to be seen where the treated and the untreated seed were used. *It should be noted, in this connection, that on the whole the crop here was very clean and the sorting exceptionally close.* The difference either way would have been of no practical importance.

Report of the Experiment in Coöperation with Mr. Walter Minch, Bridgeton, N. J.

This experiment was an exact duplication of the one carried out at Burlington. The corrosive sublimate treatment of the seed was substituted for formalin. Due to the large rainfall in 1915 the results of this experiment were influenced somewhat by faulty topography. In the normal year of 1916 such differences were not apparent, and the results show more nearly the probable effect of sulfur in this vicinity. Second-crop seed grown by Mr. Minch was used.

The results of this experiment are shown in Table XIX.

Table XIX

Results of Sulfur-Potato Scab Experiment Conducted in Coöperation with Mr. Walter Minch, Bridgeton, N. J., Summer of 1916

Plot No.	Seed Treatment	Sulfur, Pounds Per Acre		Actual Percentage of Clean Tubers	Calculated Percentage of Clean Tubers.	Difference.	Actual Yield, Bushels Per Acre.	Calculated Yield, Bushels Per Acre	Difference, Bushels Per Acre
		1915	1916						
1,	$Hg\ Cl_2$,	Check	Check	39.02	....	....	203.66	....	....
2,	$Hg\ Cl_2$,	Check	Check	48.08	....	....	229.00	....	....
3,	$Hg\ Cl_2$,	Check	Check	54.35	....	....	188.08	....	....
4,	$Hg\ Cl_2$,	Check	Check	51.85	....	....	142.16	....	....
5,	$Hg\ Cl_2$,	600	600	61.70	....	+28.08	194.75	217.88	−23.13
6,	$Hg\ Cl_2$,	300	300	59.30	33.62	+ 9.19	214.83	240.55	−25.72
7,	$Hg\ Cl_2$,	600	600	62.88	50.11	+ 7.83	204.55	206.66	− 2.11
8,	$Hg\ Cl_2$,	300	Check	59.85	55.05	+ 6.51	202.83	168.66	+34.17
9,	$Hg\ Cl_2$,	600	Check	43.20	53.34	+15.87	211.58	232.10	−20.52
10,	$Hg\ Cl_2$,	300	Check	58.00	27.33	+ 6.46	233.66	252.10	−18.44
11,	$Hg\ Cl_2$,	600	Check	58.72	52.14	+ 2.98	207.00	225.24	−18.24
12,	$Hg\ Cl_2$,	300	Check	53.40	55.75	− 1.97	193.33	195.16	− 1.83
13,	$Hg\ Cl_2$,	Check	Check	21.04	55.33	....	240.33	....	....
14,	$Hg\ Cl_2$,	Check	Check	34.18	....	....	283.66	....	....
15,	$Hg\ Cl_2$,	Check	Check	56.45	....	....	248.83	....	....
16,	$Hg\ Cl_2$,	Check	Check	57.33	....	....	221.66	....	....
17,	$Hg\ Cl_2$,	Check	Check	20.45	....	....	180.08	....	....
18,	Untreated,	Check	Check	30.88	....	....	222.14	....	....
19,	Untreated,	Check	Check	38.72	....	....	191.66	....	....
20,	Untreated,	Check	Check	47.26	....	....	183.33	....	....
21,	Untreated,	600	600	27.78	16.16	+11.62	191.66	182.25	+ 9.61
22,	Untreated,	300	300	24.65	23.61	+ 1.04	164.33	216.26	−51.93
23,	Untreated,	600	600	29.81	30.69	− 0.88	176.33	184.80	− 5.47
24,	Untreated,	300	300	23.73	36.97	−13.24	171.88	184.75	−12.92
25,	Untreated,	600	Check	19.92	11.87	+ 8.05	153.50	184.02	−30.52
26,	Untreated,	300	Check	17.00	16.33	+ 0.67	120.10	210.38	−90.28
27,	Untreated,	600	Check	28.56	22.65	+ 5.91	204.50	177.94	−26.56
28,	Untreated,	300	Check	22.07	26.71	− 4.64	223.58	186.17	+37.41
29,	Untreated,	Check	Check	7.58	....	....	186.00	....	....
30,	Untreated,	Check	Check	9.05	....	....	204.50	....	....
31,	Untreated,	Check	Check	14.61	....	....	171.08	....	....
32,	Untreated,	Check	Check	16.43	....	....	187.58	....	....

* $Hg\ Cl_2$ is Corrosive Sublimate.

The results of this experiment more nearly coincided with those previously obtained. The more important features to be noted are as follows:

(1) The corrosive-sublimate-treated seed gave a yield which is roughly 25 to 30 per cent cleaner than that obtained from the untreated seed. Likewise, there is apparently a larger yield from the treated than from the untreated seed.

(2) The application of sulfur has resulted in a decreased yield. Such a wide variation exists in the amount of this decrease that one could not say that the second-year application had resulted in an additional decrease.

(3) In general, the decreased amount of scab is correlated with the increased rate of application. This is much more apparent in the second year when no additional sulfur was applied. The results from the second-year applications are somewhat irregular but apparently there is no marked difference between the heavy and light applications when continued through the second year.

Report of the Experiment in Coöperation with Mr. H. W. Ridgeway, Bridgeton, N. J.

This experiment represents the second-year work as previously outlined. It was unfortunate that through an error the entire area occupied by the experiment was not again planted to potatoes so that the entire plot scheme was not repeated.

The object of this experiment was to test the efficiency of limestone and sulfur mixtures for the purpose of eliminating some of the undesirable features attendant upon the use of pure sulfur. The differences obtained in 1915 were too slight to merit very definite conclusions.

While some discrepancies exist in the data as shown in Table XX, the results are on the whole quite promising.

Several instances are to be noted where the sulfur and limestone mixtures have increased the yield quite materially. But it will also be observed that sulfur alone once increased the yield and limestone alone decreased it. Such an occurrence renders very definite conclusions invalid.

(1) Due to the fact that the plot treatments could not be repeated, it is impossible to state the influence of the sulfur and limestone mixtures on the yields.

(2) In the control of scab the pure sulfur gives only slightly better results than the limestone mixtures.

(3) Sulfur alone is less effective on plots limed in 1915 than where no lime was applied.

(4) The application of limestone has not favored the development of scab to the extent that might have been expected.

Table XX

Results of Sulfur-Potato Scab Experiment in Coöperation with Mr. H. W. Ridgeway, Bridgeton, N. J., Summer of 1916

Plot No.	Treatment, Pounds Per Acre		Yield in Bushels Per Acre			Percentage of Clean Tubers		
	1915	1916	Actual	Calculated	Difference	Actual	Calculated	Difference
1	Check	Check	175.83	....	....	44.30	....	....
2	Check	Check	166.66	....	....	45.36	....	....
3	Check	Check	172.50	....	....	40.91	....	....
4	Check	Check	165.66	....	....	39.45	....	....
5	Check	Check	180.25	....	....	38.20	....	....
6	Check	Check	182.75	....	....	34.82	....	....
7	Check	Check	197.33	....	....	35.46	....	....
8	Check	Check	210.66	....	....	29.70	....	....
9	Check	Check	227.33	....	....	38.84	....	....
10	[1]S. 600	S. 600	193.16	197.41	− 4.25	60.85	48.16	+12.69
11	S. 600 [2]L. 600	S. 600 L. 600	185.66	194.88	+ 9.22	56.08	40.25	+15.83
12	L. 300 S. 600 L. 300	L. 300 S. 600 L. 300	201.66	197.78	+ 4.04	47.24	37.10	+10.14
13	Limestone 300	S. 600	222.08	195.55	+26.53	44.20	39.00	+ 5.20
14	L. 600	S. 600	202.33	190.61	+11.72	42.5	37.70	+ 4.80
15	S. 600	L. 300 S. 600	171.66	185.44	−13.78	30.45	32.54	− 2.09
16	S. 600	L. 600 S. 600	178.25	204.10	−25.85	43.25	36.22	+ 7.03
17	Check	S. 600	228.83	227.56	+ 1.27	58.40	37.20	+21.20
18	Check	S. 600 L. 300	246.58	229.33	+17.25	55.05	36.71	+18.34
19	S. 600	Check	239.18	218.99	−20.09	55.28	52.02	+ 3.26
20	S. 600 L. 600	Check	234.16	224.10	−10.06	35.80	35.15	+ .65
21	S. 600 L. 300	Check	228.16	223.06	− 4.90	36.86	33.30	+ 3.56
22	L. 300	Check	209.33	225.44	−16.11	45.20	38.56	+ 6.44
	S. 600	L. 300	219.41	188.13	+31.28	27.39	30.27	− 2.88
23	L. 300	Check	211.33	200.97	+10.36	31.08	37.20	− 6.42
25	S. 600	L. 600	197.66	210.87	−13.21	32.18	38.22	− 6.04
26	Check	L. 600	177.16	244.56	−67.40	47.27	44.70	+ 2.57
27	Check	L. 600 S. 600	227.66	231.33	− 3.67	52.30	35.08	+17.22
28	Check	Check	240.66	....	....	55.90	....	....
29	Check	Check	254.83	....	....	30.05	....	....
30	Check	Check	258.33	....	....	29.50	....	....
31	Check	Check	255.33	....	....	38.12	....	....
32	Check	Check	221.50	....	....	36.70	....	....
33	Check	Check	191.66	....	....	28.00	....	....
34	Check	Check	217.66	....	....	39.64	....	....
35	Check	Check	261.57	....	....	52.20	....	....
36	Check	Check	233.33	....	....	33.45	....	....

[1] S—Sulfur. [2] L—Lime.

Experiment in Coöperation with Mr. Earl Dilatush, Robbinsville, N. J.

It was impossible to continue the work on the soil under experiment in 1915 at Robbinsville, and because of the unsatisfactory results obtained from the sulfur-limestone mixtures, it was thought advisable to substitute a test of this material here.

The soil type and general management on this field is the same as previously reported. The experiment consisted of 7 plots each 200 feet long and 4 rows wide. Their arrangement and treatment is shown in Table XXI.

This plot was about the last planted by Mr. Dilatush in the spring and a mixed stand of Irish Cobblers and Green Mountains resulted. On the whole, the amount of scab did not vary greatly with variety, and little error in the result can be attributed to this source.

Table XXI

Results of Sulfur-Potato Scab Experiment in Coöperation with Mr. Earl Dilatush, Robbinsville, N. J. Summer of 1916.

Plot No.	Treatment, Pounds Per Acre	Yield in Bushels Per Acre			Percentage of Clean Tubers		
		Actual	Calculated	Difference	Actual	Calculated	Difference
1,	Check,	222.00	....	....	30.00	....	....
2,	Sulfur, 600,	208.33	214.42	-6.09	29.35	24.44	+4.89
3,	Check,	206.83	....	....	18.88	....	....
4,	Sulfur, 600, Limestone, 300,	201.50	216.75	-15.25	34.92	27.24	+7.68
5,	Check,	226.66	....	....	35.59	....	....
6,	Sulfur, 600, Limestone, 600,	222.83	259.66	+36.83	28.48	34.33	-5.85
7,	Check,	282.66	....	....	33.07	....	....

No real decrease in the yields due to any of the treatments can be claimed. With the exception of Plot 7, all of the plots show as great regularity in yield as is usually to be obtained if all the plots are alike. The abnormally large yield on Plot 7 makes an apparent increased yield on Plot 6. A glance at the yields of the first six plots will show that the actual yield on Plot 6 is probably the normal yield.

In the matter of scab control the actual differences either way are too small to warrant serious consideration. Just why sulfur alone should be less effective than a mixture of sulfur and limestone, 2 to 1, is not apparent, particularly so since the 1 to 1 mixture shows more scab than the calculated percentage. It might be possible for the extra 300 pounds of limestone per acre actually to cause this reversal, but it hardly seems probable.

Experiment in Coöperation with Mr. J. Carroll Burtis, Allentown, N. J.

Very much the same conditions prevailed at Allentown as at Robbinsville and another test of the sulfur-limestone mixture was substituted in place of the one already started.

The plots of this experiment were 300 feet long and 4 rows wide. More soil was available here and an additional plot for limestone alone made this experiment more complete.

The results of the experiment are shown in Table XXII.

Table XXII

Results of Sulfur-Potato Scab Experiment Conducted in Coöperation with Mr. J. Carroll Burtis, Allentown, N. J. Summer of 1916

Plot No.	Treatment, Pounds Per Acre	Yield in Bushels Per Acre			Percentage of Clean Tubers		
		Actual	Calculated	Difference	Actual	Calculated	Difference
1,	Check,	127.80	....	....	35.82	....	....
2,	Limestone, 300, Sulfur, 600,	143.91	132.02	+11.89	34.78	27.55	+7.23
3,	Check,	136.25	....	....	91.28	....	....
4,	Sulfur, 600,	143.91	148.04	– 4.13	28.55	20.28	+8.27
5,	Check,	159.83	....	....	21.28	....	....
6,	Sulfur, 600, Limestone, 600,	183.58	149.70	+33.88	21.35	14.92	+6.43
7,	Check,	139.58	....	....	8.57	....	....
8,	Limestone, 600,	197.66	139.58	+58.08	2.04	8.57	–6.53

The results of this experiment show a very consistent effect of both *the sulphur and the limestone. In fact, this experiment is the only one of* the five of this type showing such tangible results. Limestone alone increased the yield 58 bushels per acre, and regularly as the quantity is decreased the yield is decreased.

In the control of scab, the percentage of clean tubers decreases as the amount of limestone is increased. The actual differences are small, but they are significant in view of the fact that the limestone alone has increased the amount of scab by 6 per cent.

Report of the Experiment in Coöperation with Mr. M. F. Riley, Elmer, N. J.

This experiment is a continuation of the one started here in 1915. The object of the work was to determine the influence of the various methods of application on the efficiency of sulfur. The results of this experiment last year showed very marked differences due to these factors.

*The results this year, as shown in Table XXIII, confirm in a large meas*ure, the conclusions drawn from the previous work.

The following points are apparent from the data of this experiment:

(1) Broadcasting of the sulfur before planting is apparently the most efficient means of applying sulfur.

(2) *The use of sulfur in mixture with the fertilizer,* while effective in the control of scab, results in an abnormally large decrease in the yield. Such a mixture of fertilizer with a large quantity of sulfur is not to be recommended.

(3) Broadcasting of the sulfur before planting has brought about an *increase in the yields*.

(4) Applications of sulfur a second season brought about a decrease in the amount of scab and also a decrease in the yield.

Table XXIII

Results of Sulfur-Potato Scab Experiment Conducted in Coöperation with Mr. M. F. Riley, Elmer, N. J., Summer of 1916

Plot No.	Sulfur, 600 Pounds Per Acre		Percentage of Clean Tubers			Yield in Bushels Per Acre		
	1915	1916	Actual	Calculated	Difference	Actual	Calculated	Difference
1, ...	Check, ...	Check, ...	18.10	....	....	142.0	....	....
2, ...	Mixture with fertilizer, ...	Mixture with fertilizer, ...	69.85	20.22	+ 49.63	62.50	142.22	− 79.72
3, ...	Mixture with fertilizer, ...	Check, ...	46.10	22.34	+ 23.76	147.91	144.44	− 3.47
4, ...	Check, ...	Check, ...	24.47	....	....	142.66	....	....
5, ...	Broadcast after planting, ...	Same, ...	25.57	23.28	+ 2.29	123.50	129.70	− 6.20
6, ...	Broadcast after planting, ...	Check, ...	22.07	22.10	− .03	130.86	117.35	+ 13.51
7, ...	Check, ...	Check, ...	20.92	....	....	105.00	....	....
8, ...	*Broadcast before planting,*	Same, ...	72.86	19.21	+ 53.65	120.58	105.88	+ 14.70
9, ...	Broadcast before planting,	Check, ...	33.15	17.52	+ 15.63	139.50	106.76	+ 32.74
10, ...	Check, ...	Check, ...	15.83	....	....	107.66	....	....
11, ...	Check, ...	Broadcast before planting,	47.80	14.14	+ 33.66	161.0	107.66	+ 53.34

(5) The second year influence of sulfur in the control of scab is very perceptible in this experiment.

This phase of the experimental work of the Department is more briefly reported this season than heretofore, in view of the fact that a complete resumé of the entire investigation is to be prepared in the form of a bulletin. The general summary and recommendations are reserved for that publication.

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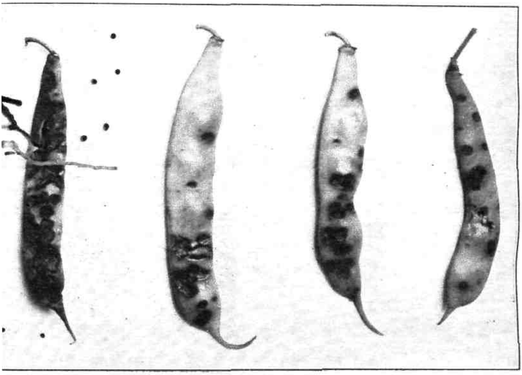


Fig. 1.—Bean Anthracnose (*Colletotrichum lindemuthianum*). Photo by H. B. North.

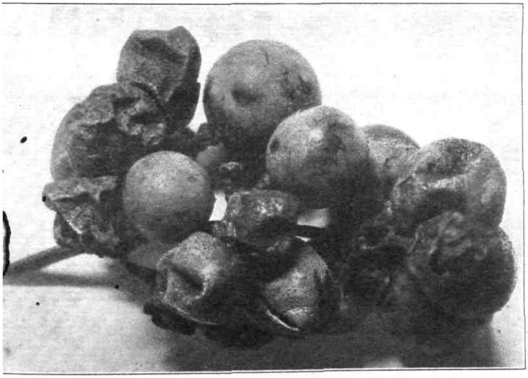


Fig. 2.—Grape Rot (*Melanconium fuligineum*). Photo by W. S. Krout.

Fig. 1.—Bacterial disease of peach (*B. pruni*). Photo by C. H. Connors.

Fig. 2.—Bacterial disease of peach (*B. pruni*). Photo by C. H. Connors.

PLATE IV.

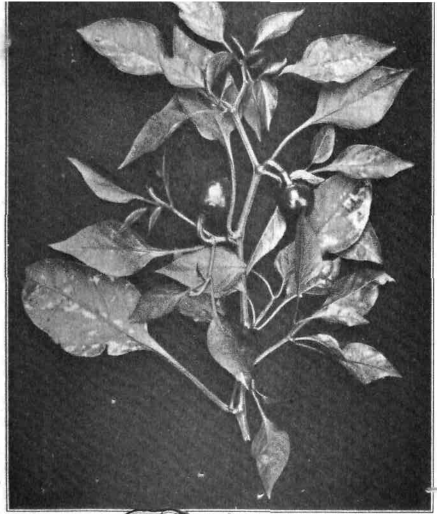


Fig. 1.—Pepper mosaic.

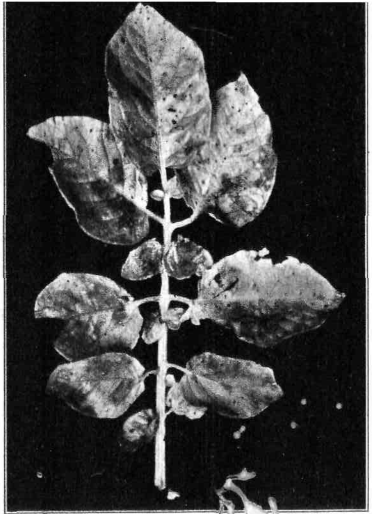
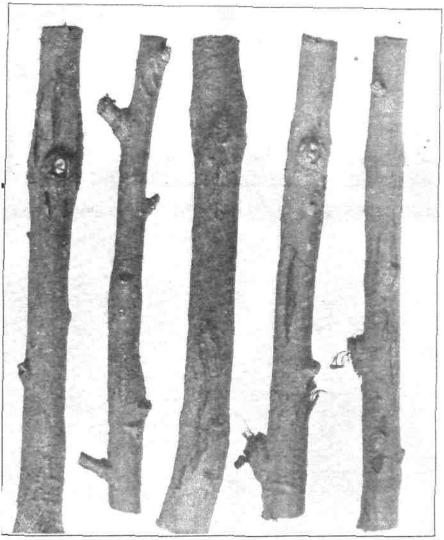


Fig. 2.—Early blight of the potato (...*aria solani*).



?.—Poplar twig blight (*Dothichiza populæ*). Photo by C. H. Connors.